No.99MBC032A3
SERIES No.544

LSM-9506

Laser Scan Micrometer

User's Manual

Read this User’s Manual thoroughly
before operating the instrument. After reading,
retain it close at hand for future reference.

Mitutoyo

CONVENTIONS USED IN USER'S MANUAL

Safety Precautions

To operate the instrument correctly and safely, Mitutoyo manuals use various safety signs (Signal Words and Safety Alert Symbols) to identify and warn against hazards and potential accidents.

The following signs indicate **general** warnings:

DANGER

Indicates an imminently hazardous situation which, if not avoided, will result in serious injury or death.

WARNING

Indicates a potentially hazardous situation which, if not avoided, could result in serious injury or death.

CAUTION

Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury or property damage.

The following signs indicate **specific** warnings or prohibited actions, or indicate a mandatory action:

Alerts the user to a specific hazardous situation. The given example means “Caution, risk of electric shock”.

Prohibits a specific action. The given example means “ Do not disassemble”.

Specifies a required action. The given example means “Ground”.

CONVENTIONS USED IN USER'S MANUAL

On Various Types of Notes

The following types of **notes** are provided to help the operator obtain reliable measurement data through correct instrument operation.

IMPORTANT

- An *important note* is a type of note that provides information essential to the completion of a task. You cannot disregard this note to complete the task.
- An important note is a type of precaution, which if neglected could result in a loss of data, decreased accuracy or instrument malfunction/failure.

NOTE A *note* emphasizes or supplements important points of the main text. A note supplies information that may only apply in special cases (e.g.. Memory limitations, equipment configurations, or details that apply to specific versions of a program).

TIP A tip is a type of note that helps the user apply the techniques and procedures described in the text to their specific needs.
It also provides reference information associated with the topic being discussed.

NOTES FOR EXPORTING

If you export this product, contact the nearest Mitutoyo sales office in advance.

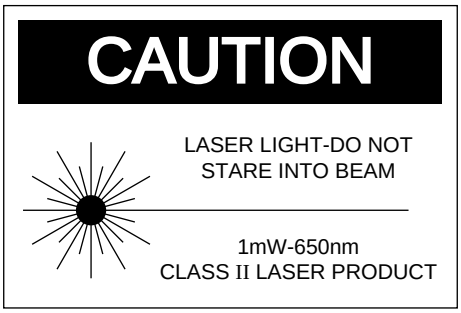
PRECAUTIONS

1. Safety Precautions

CAUTION

The Mitutoyo Laser Scan Micrometer LSM-9506 uses a laser beam.

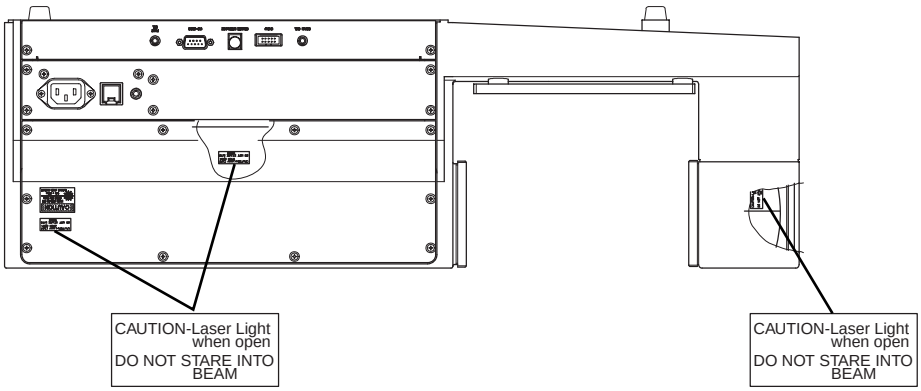
1) "This LSM conforms to the US CDRH regulations in 21 CFR 1040 for a class II laser product."
2) Do not look directly into the laser beam. (Never look into the emission window, even when no light is emitted.)
3) Do not observe the laser beam directly through optical equipment, such as a magnifying lens.
4) When measuring flat objects with mirror finishes, avoid looking at the reflection on the surface.
5) Close the beam shutter when not in use.
6) Do not open the emission unit cover except for servicing. The output power when the cover is open is about 1.2mW.
7) Do not remove the "CAUTION" or "WARNING" labels.
8) The laser beam does not harm human skin when irradiating.
9) "CAUTION – Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure."

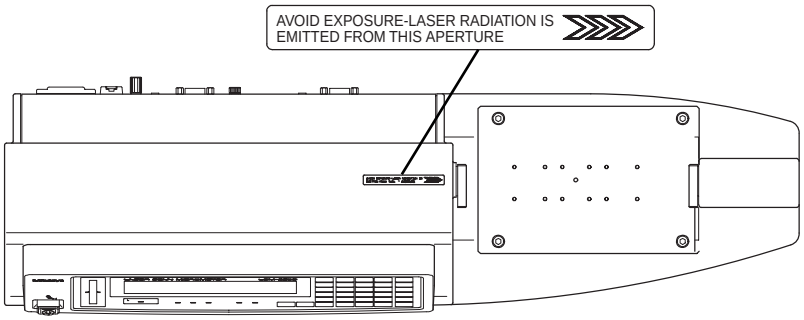


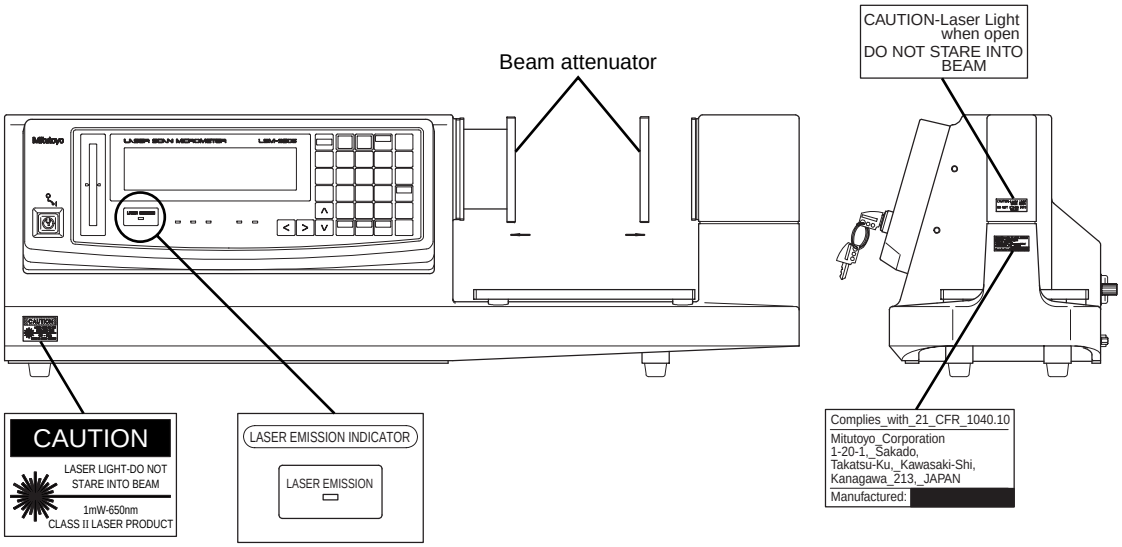
2. If an optional device is to be connected to this system, make sure that the optional device is also turned off.
3. Firmly tighten the screws of the cable connectors and interfaces to ensure shielding.
4. Do not touch the terminals of the connectors, otherwise contact may be poor.
5. Positively ground the Display Unit.
6. An error display may appear during operation. However, it may not always indicate a fault. If an error display appears, consult the "Maintenance and Inspection" section.

Do not open the covers provided on the emission unit and reception unit.

SAFETY PRECAUTION LABELS LOCATED ON LSM-9506







INSTALLING CONDITIONS

The Mitutoyo Laser Scan Micrometer LSM-9506 is both a precision optical instrument and a precision electric instrument, and it is designed for indoor use. Therefore, it must be carefully installed and the following conditions must be taken into consideration to attain the highest possible accuracy.

1. Vibration
   Install this unit if possible in a place where it will not be subject to vibration. If this unit is used for a long period of time in an environment where there are significant vibrations, the precision parts in this unit may be affected, resulting in the deterioration of measuring accuracy.

   If this unit has to be used in an environment where vibration is significant, measures such as the laying of a vibration damping rubber pad under the unit must be applied to reduce the effect of vibration.

2. Dust
   Dust and airborne particles at the installation site adversely affect optical parts including the protective glass and electronic parts of the Measuring Unit. Place this unit in a place with as little dust and as few airborne particles as possible.

3. Direct sunlight
   If this unit is subjected to direct sunlight, the heat may deform this unit and affect the measuring accuracy.

   If this unit must be placed by a window where it will be subjected to direct sunlight, protect the unit by shading it.

4. Ambient temperature and humidity
   This unit must be operated in an environment where the temperature is between 0 and 40˚C and the humidity is between 35 and 85% RH. Avoid installing this unit where there is significant temperature or humidity change.

   Significant temperature and humidity changes may reduce measuring accuracy.

WARRANTY

In the event that the Mitutoyo Laser Scan Micrometer (LSM) should prove defective in workmanship or material, within one year from the date of original purchase for use, it will be repaired or replaced, at our option, free of charge upon its prepaid return to us.

If the unit fails or is damaged because of the following causes it will be subject to a repair change, even if it is still under warranty.

1. Failure or damage due to inappropriate handling or unauthorized modification.
2. Failure or damage due to transport, droppage, or relocation of the machine after purchase.
3. Failure or damage due to fire, salt, gas, abnormal voltage, or natural catastrophe.

This warranty is effective only where the machine is properly installed and operated following this manual.

CONTENTS

1 INTRODUCTION

This chapter describes the Laser Scan Micrometer (LSM) models and nomenclature of the Display unit and the Measuring unit.

1.1 Outline

This system is an accurate, non-contact measurement system capable of measuring workpiece dimensions at a high speed using a highly directional scanning laser beam.

This non-contact optical measuring system is capable of measuring workpieces which are difficult to measure with conventional measuring instruments. It performs simple and accurate measurement of brittle or elastic objects, objects at high temperature, objects which must be kept clean, and soft objects which may be deformed and suffer dimensional changes under the measuring forces used.

1.2 Foreword

WARNING

The Measuring Unit uses a laser. For safe operation, carefully read and follow the "Safety Precautions on Use of Laser" section described in the user's manual that is supplied with each Measuring Unit.

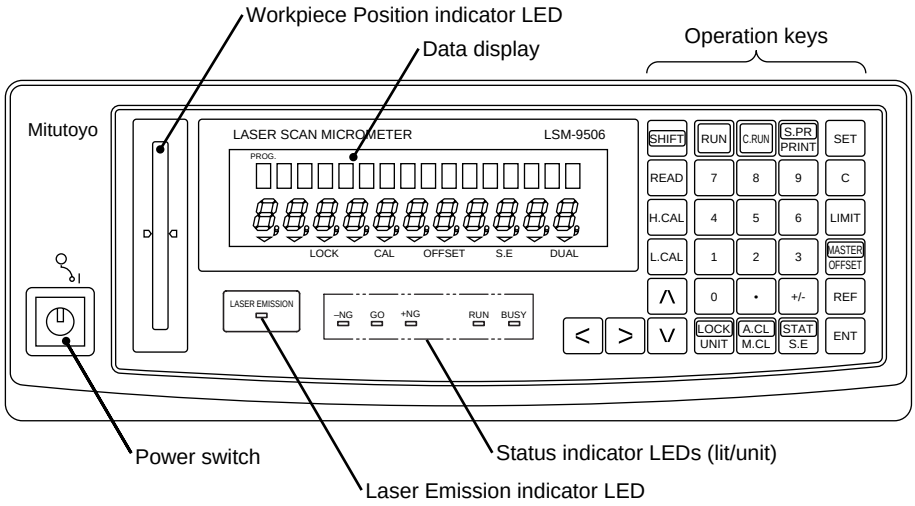
The LSM-9506 is classified into two types, the mm/E type and mm/inch type. This User's Manual explains about the mm/E type. In case of using the mm/inch type, read this User's Manual with replacing the "E" indication with "inch (in)".

1.3 Nomenclature

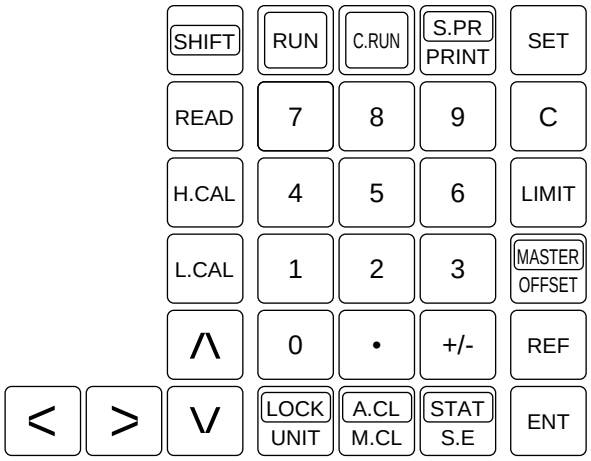
This section gives the name of each part in the LSM system.

1.3.1 Display Unit

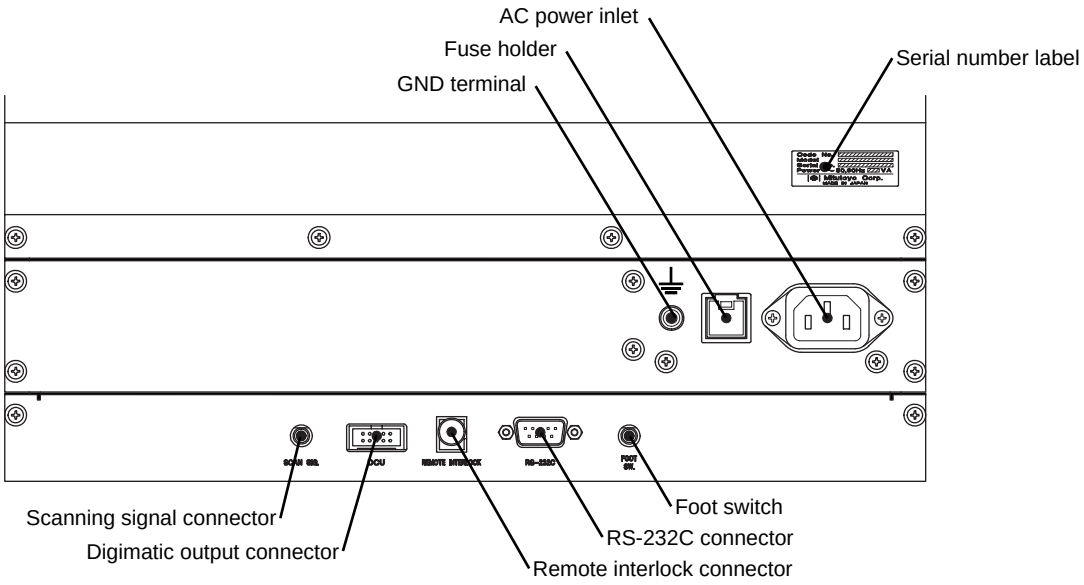
(1) Front panel



(2) Displays and keys



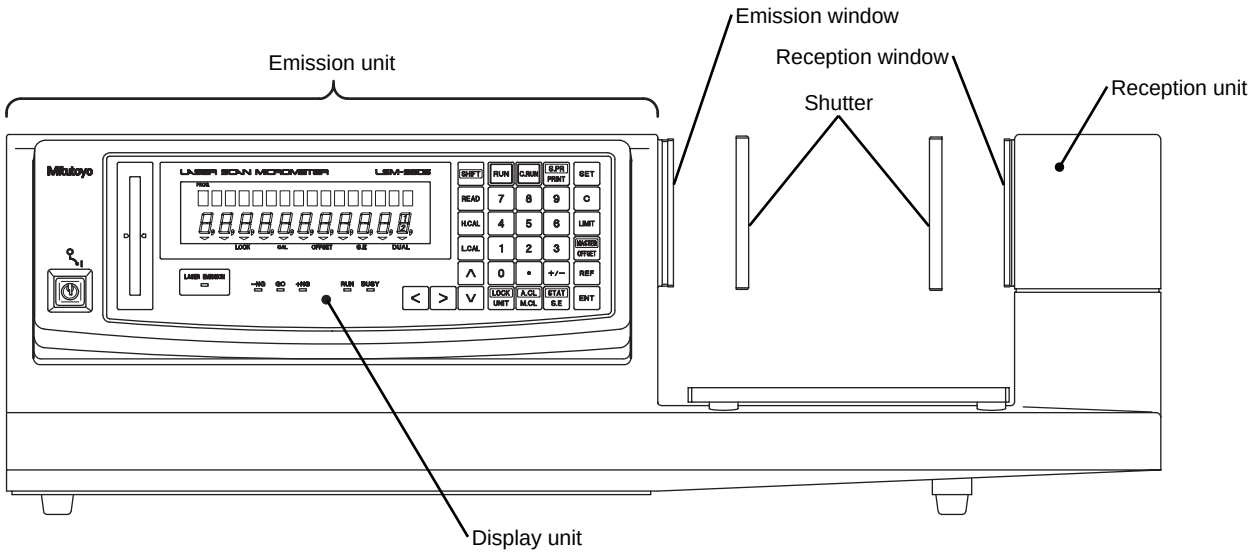
(3) Rear panel



TIP The terminal located at the left end of the power input terminal and marked (by a symbol ⏚ or ⏚) is the grounding terminal to keep the potential of signal line of this unit equal with other instrument connected. It is used to enhance resistance against electrical interference.

1.3.2 Measuring Unit

(1) Measuring Unit



MEMO

2 SETUP

This chapter describes the connection between the Display Unit and Measuring Unit.

2.1 Unpacking and Acceptance Check

Your LSM has been thoroughly inspected prior to shipment. The mechanical, electrical, and optical systems are guaranteed to operate properly.

Unpack the package and check that the main unit is not damaged, and all the accessories listed are present.

Contact Mitutoyo if anything is damaged or missing.

2.2 Connecting the Cables

Make sure that the power switch is turned off (turn the key switch counterclockwise to align with “O”, then pull it out), then connect the cables according to the following procedure.

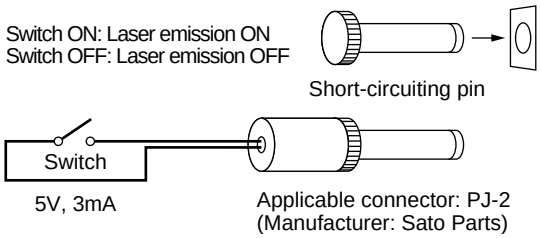
Step 1: Connecting the power cord and GND lead wire
Connect the supplied power cord to the AC connector on the rear panel of the main unit. Also be sure to ground the main unit with the GND lead wire for improved resistance to noise.

Grounding must be done properly:
Connect the supplied grounding wire, after cutting it to the minimum length, to the grounding terminal provided on the Display Unit. This unit operates as a precision analog processor and, at the same time, a high-speed calculation unit. To enhance resistance against electrical interference and to increase safety, do not neglect grounding.

Step 2: Checking the remote interlock connector

Make sure that the short-circuiting pin is inserted into the “REMOTE INTERLOCK” connector on the rear panel of the Display Unit. If this short-circuiting pin is not inserted, laser emission is disabled, even if the power switch is on.

To emergency stop laser emission, refer to the following diagram.



Step 3: Connecting the interface

For information about the procedure used to connect the interface, refer to Section 6.1, “RS-232C Interface” and Section 6.2, “Digimatic Output Unit Interface”.

IMPORTANT Note the following when making cable connections.
Always make connection or disconnection with the power cord unplugged. In addition, before connecting to the interface make sure that the power to all other units connected or to be connected are also off.

Do not disassemble this unit. This unit is a precision instrument. Should it be disassembled by the user, its accuracy can not be guaranteed even within the term of its warranty. And, there will be a charge for repairs.

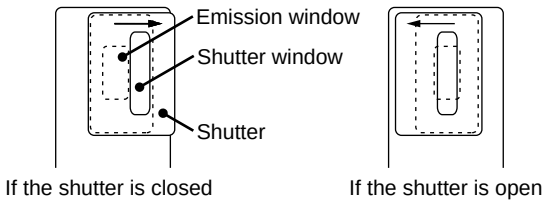
Observe the following to avoid electric shock.

1. Do not remove the protective cover on which the seal is stuck to. Otherwise, an electric shock may result.
2. Do not remove the seal, shown at the left.

2.3 Preliminary Checks

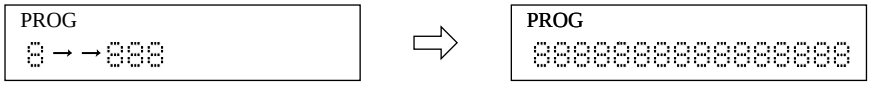
The necessary connections should be completed by following the procedure described in the previous chapter. Simplified operation checks are described here.

Step 1: Fully open the lens cap and shutter of the Measuring Unit.
Fully open the lens caps and beam shutters of both the emission unit and reception unit to ready the laser beam for emission.
The lens caps should be completely removed, and the shutters should be as shown in the diagram below.

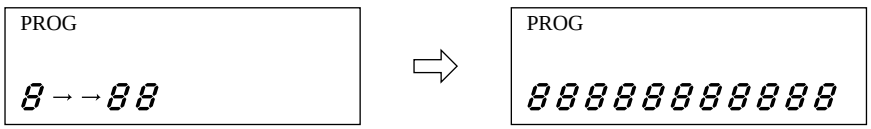


Step 2: Power on

- Turn the power key switch on the Display Unit clockwise until it is in the I (power on) position and the power is on.
- This unit enters the self check mode and all the LEDs and segments turn on. They will turn off shortly, and eights ▩ will be displayed in the upper display section. When 8888···8 is displayed across the upper display section, the unit will turn off shortly. This is followed by the self check on the lower display section.

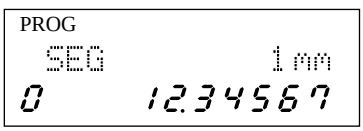


- In the lower display section eights 8 will appear sequentially from the left to right.
- After 8888888888 is displayed across the lower display section, it will turn off shortly.



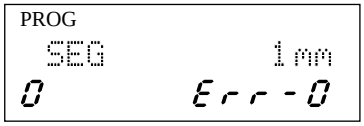
- Measurement is started.
The LASER EMISSION LED turns on and the BUSY LED starts flashing to indicate the measurement has started from the ready state.

Since the objective segment has been set to "SEG 1" at the factory, the displayed measurement shows the laser scanning range of the Measuring Unit.



Here, the Display Unit is found to be normal because the scanning range is displayed.
Proceed to Chapter 3, "FUNCTIONS AND KEY OPERATIONS", to custom set up each function.

- An error may be displayed at this stage, however, the display at the right is not actually an error. Check the shutter of the Measuring Unit.



For information about other errors that may result refer to Section 7.3, “Error Messages and Remedies”.

2.4 Initializing the LSM-9506

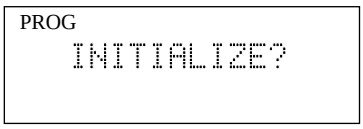
After making sure that this unit is operating normally, initialize the LSM-9506.

The initialization procedure is as follows:

Step 1: Turn off the power.

Step 2: Turn on the power while holding down the [C] key.
Hold down the [C] key for approximately 2 seconds, even after the power is on.

Step 3: When the self check has been completed, the display shown at the right will appear. To initialize, press the [ENT] key. When the initialization process has been completed, the display restores the initial conditions that existed just after the power on.



To abort initialization press a key other than the [ENT] key or turn the power off. In the former case the initialization process will be aborted and the initial display at power-on will be restored.

IMPORTANT Initialization will clear all the customer setup data and will restore the factory-setups. Customize the setups again as necessary.

MEMO

3 DISPLAYS AND KEY OPERATIONS

This Display Unit is provided with many useful functions that can be customized according to the user's needs.

This chapter describes these functions and key operations.

3.1 Outline of the Operation Modes

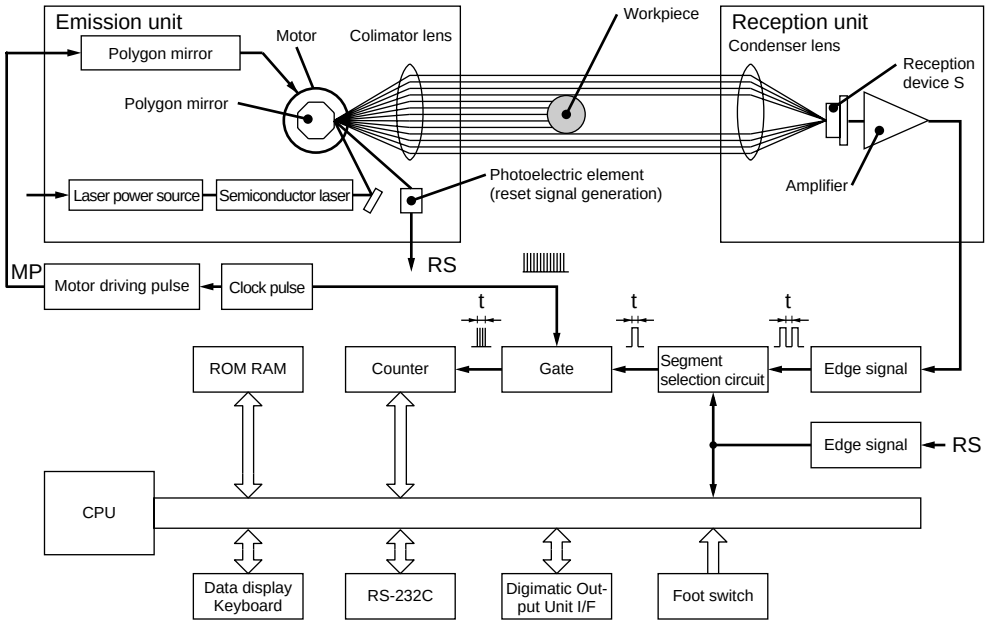
3.1.1 Outline of the Operation Modes

In order for the user to understand the measurement principle of the LSM, the following paragraphs describe about the system block diagram, segments (measurement positions) and measurement interval (measurement time).

3.1.1.1 Overview

Unlike light emitted from natural sources, a laser provides extremely fine, rectilinear beams which do not diffuse (coherent light beams).

Using the properties of the laser beam, the Mitutoyo Laser Scan Micrometer (LSM) moves a scanning laser beam over the workpiece and determines its dimensions by measuring the duration in which the beam is obstructed by the workpiece.



The configuration of the system is shown in the block diagram described in the previous page. A laser beam emitted from the laser oscillator is directed at the polygon mirror which rotates at high speed and is synchronized by clock pulses. The laser beam that is reflected by the polygon mirror is then collimated by the collimator lens towards the workpiece. As the polygon mirror rotates, this horizontal beam scans the workpiece and the beam not obstructed by the workpiece will reach the photoelectric element through the condenser lens and induce an output voltage in the photoelectric element. The output voltage will change according to the duration over which the laser beam is obstructed. Counting pulses generated during that period are used to determine the dimension of the obstructed portion. This data is sent to the CPU for processing and the dimensions are displayed digitally.

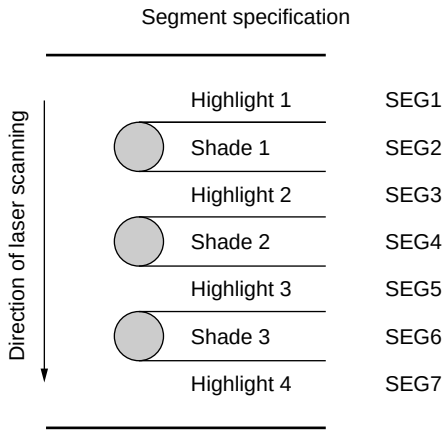
Consequently, either the dimensions of the workpiece (shadowed areas) or workpiece clearances (highlighted areas) can be determined by specifying the segments to be measured.

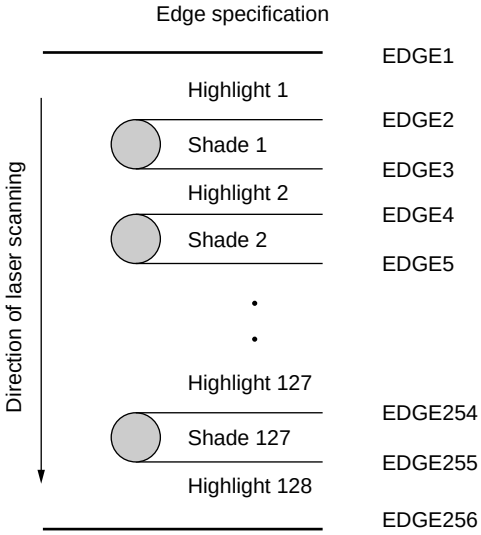
TIP In the above system block diagram, the laser beam passed through the collimator lens is made parallel and, at the same time, stopped down so that the beam diameter is minimized at the measurement position.

3.1.1.2 Setting the segment

Set the objective portion of a workpiece to be measured.

The highlighted and shaded portions created when the laser scans over the workpiece are controlled with each assigned number. In the basic setup a selection must be made from one of two cases: case where there are 1 to 4 highlighted and shaded sections, and case where there are 1 to 127 similar sections. In the former case the portions are controlled through the segment number, and are simply called segments. In the latter case the portions are controlled by the edge number (edge number is between 1 and 255) and called edges. Edge numbers equal to or greater than 256 are not available.





- A maximum of 4 highlighted sections and a maximum of 3 shaded sections can be measured.
- Multiple segments can be specified at the same time.
- Specify segments 1 to 3 for a transparent object.

- A maximum of 127 highlighted sections and a maximum of 127 shaded sections can be measured.
- Always specify the start edge and finish edge numbers. These two edges can be either continued or separated. However, they must not be identical.
- Edge numbers can not be specified for a transparent object.
- If automatic measurement is specified in the basic setup, intervals, outside diameters, or gaps between the same shape of multiple pins can be automatically measured.

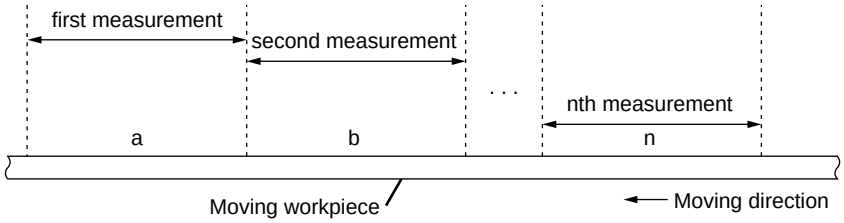
3.1.1.3 Measurement interval (measurement time)

A measurement interval (measurement time) varies depending on the averaging method and the number of scans selected for the measurement data.

There are two types of averaging method: the arithmetical average and the moving average. Select the one best suited for the user's purpose.

1) Arithmetical average

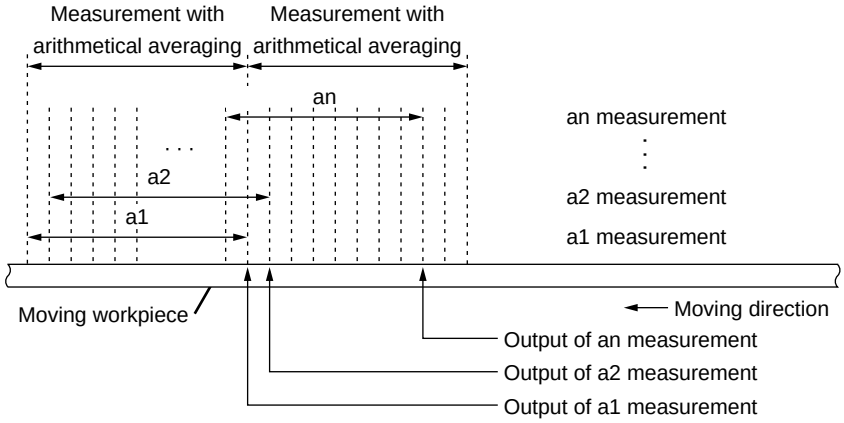
- If a moving workpiece is measured, the OD of the workpiece is determined by averaging the measured data taken from each section (a: first measurement, b: second measurement, ... n: nth measurement) of the workpiece the specified number of averaging times, as shown below.



- One of the following number of averaging times can be selected: 1, 2, 4, 8, ...1024, 2048. (If extra fine wire measurement is specified in the basic setup, the number of averaging times can be selected from between 16 and 2048.)
- This is suitable for measuring a still object or the run-out of rollers, etc.

2) Moving average

In the moving average method, a measurement interval identical to that in the arithmetical average is divided into finer sections such as a1 (1st measurement), a2 (2nd measurement), - - - , an (nth measurement). Each measurement is performed almost in parallel. If, for example, the number of averaging times is set to 512, the first measurement requires the amount of time that corresponds to 512 scans. However, for the second measurement onward, only the time for 16 scannings is required. With respect to a workpiece with a changing OD, this method provides data with smooth variation because of the many pieces of data, and also quickly detects the trend of workpiece OD variation.

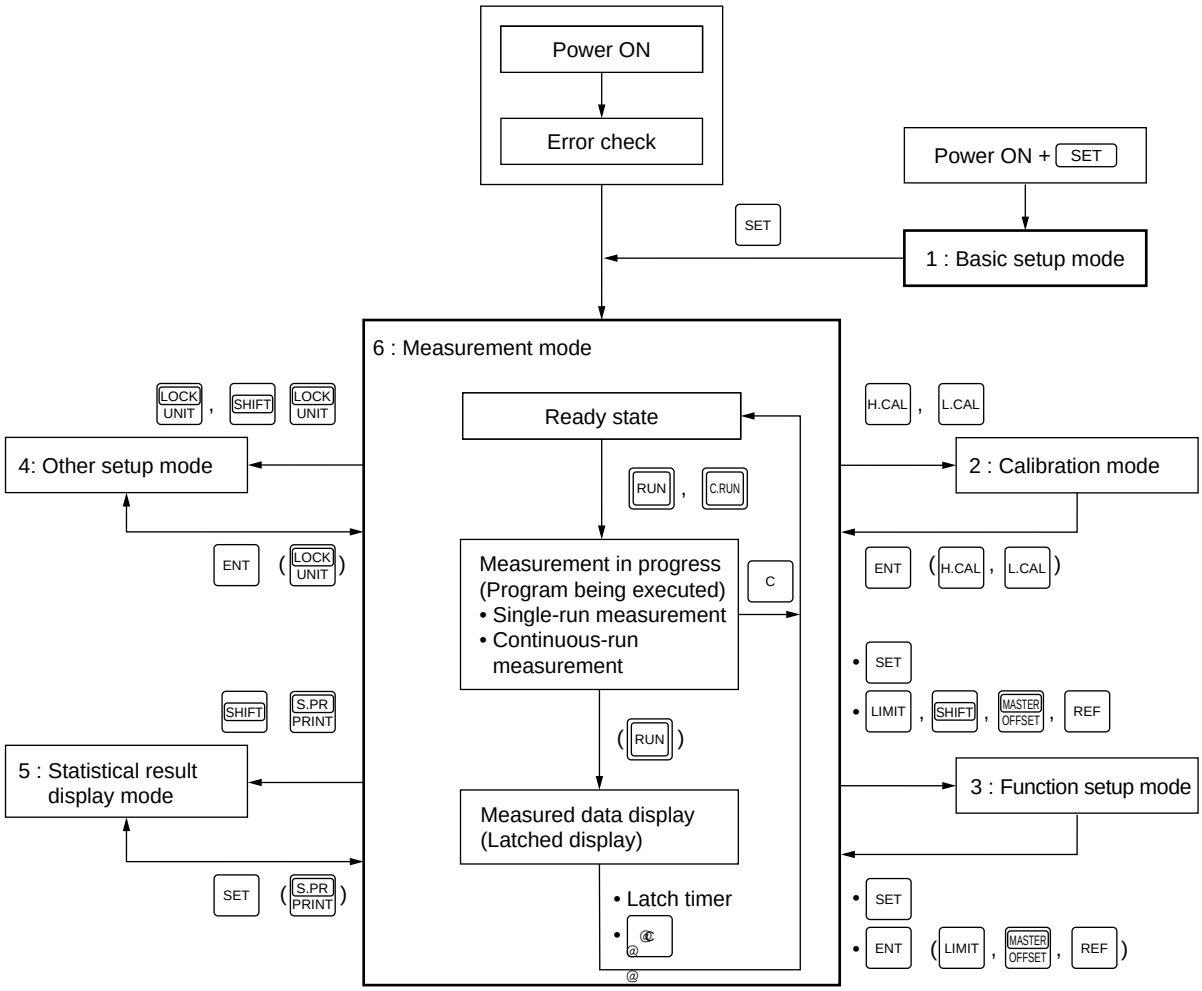


- One of the following number of scans can be selected: 32, 64, 128, ...1024, 2048.
- This method is suitable for the feedback control of wire drawing machines and extruding machines.

3.1.2 Outline of the Operation Modes

The LSM system has the following modes:

1: Basic setup mode, 2: Calibration mode, 3: Function setup mode, 4: Other setup mode, 5: Statistical result display mode, and 6: Measurement mode.



3.1.2.1 Basic setup mode

- This mode is used to customize the basic setup conditions, including the resolution, interface conditions, and available functions, according to the measurement requirements. For more information, refer to Section 4.1, “Basic Setup”.
- To enter the basic setup mode turn on the power (turn the key switch clockwise from the “O” position to the “I” position) while holding down the [SET] key. Hold down the [SET] key for about 2 seconds to initiate the basic setup mode.

3.1.2.2 Calibration mode

- Depending on the environment in which the LSM is used, measurement errors may result. Therefore, always perform calibration prior to use, taking the measuring range and environmental conditions into account.
  If calibration is performed, the errors described above will be reduced and high accuracy will be ensured.
- Before performing calibration, always make the setups for resolution, simultaneous measurement and available segments in the basic setup mode. If this order is reverse, the previously set calibration values may be discarded.
- For more information, refer to Section 4.2, “Calibration”.
- Press the [H.CAL] key to enter the HI CAL mode; and press the [L.CAL] key to enter the LOW CAL mode.

3.1.2.3 Measuring condition setup mode

- This mode is used to set up measuring conditions, including segments (objective portion of workpiece to be measured) and GO/NG judgment criteria.
- Press the [SET] key to enable all the function setup items established to be set in a batch.
- Each of the [LIMIT], [SHIFT], [MASTER]/[OFFSET], and [REF] keys allows the individual function setup item to be established.
- Press the [<] key to enter the setup operation for the setup item which is used most often.

3.1.2.4 Other setup mode

- This mode is used to set the key lock and to set the unit of measurement.
- Press the [SHIFT] and [LOCK]/[UNIT] key to turn on and off the key lock; and press only the [LOCK]/[UNIT] key to enter the unit change mode.
- Press the [SHIFT] and [READ] key to enter the measuring position display mode.

3.1.2.5 Statistic display mode

- Displays the statistical processing results.
- Press the [SHIFT] and [STAT]/[S.E] keys in the ready state to enter the statistic display mode.
- Press the [SHIFT] and [S.PR]/[PRINT] keys in the ready state to allow the statistical processing results to be printed.

3.1.2.6 Measurement mode

This mode can be divided into the following operational states:

1) Measurement in the ready state

- This is the measurement mode that is entered immediately after the power is turned on or if another measurement mode is aborted by pressing the [C] key (or by the "CL" command from the RS-232C interface).
- It is used to establish setups for calibration and available functions, which are not part of the basic setup items, or to enter another measurement mode including single-run measurement.
- Usually GO/NG judgment will not take place for measurement in the ready state, however, GO/NG judgment can be made in the basic setup mode.
- Measurements in the ready state are unavailable for statistical processing.

2) Single-run measurement

- If the [RUN] key (otherwise input "R" command via the RS-232C interface) is pressed, one session of measurement is performed and the results will be automatically subject to GO/NG judgment. In addition, the measured data will be outputted for the RS-232C interface, Digimatic Output Unit interface, and printer. The measured data will be held (latched for the specified period) in the display.
- This data will be available for statistical processing.

3) Continuous-run measurement

- If the [C.RUN] key (otherwise input "CR" command via the RS-232C interface) is pressed, one session of measurement is started and repeated the specified number of times. The measured data will be automatically subject to GO/NG judgment. In addition, the measured data will be outputted for the RS-232C interface, Digimatic Output Unit interface, and printer.
- Press the [RUN] or [C.RUN] key again to terminate the measurement and hold the measured data on the display. If the [C] key (or "CL" command via the RS-232C interface) is pressed halfway, the measurement is aborted and the ready state is returned to.
- The measurements are available for statistical processing.

4) Zero-run measurement

- A measurement where the number of samples is set to "0" is called a "zero-run measurement".
- If the [RUN] key (otherwise input the "R" command via the RS-232C interface) is pressed, single-run measurement is started and repeated until the [RUN] key is pressed again (or the "STOP" command is inputted via the RS-232C interface). From the measured data the calculation items (mean, maximum value, minimum value, and range) that have been set for the sample measurement will be calculated and the resulting data will be automatically subject to GO/NG judgment. In addition, the measured data will be outputted for the RS-232C interface, Digimatic Output Unit interface, and printer. The measured data will be held on the display.
- The measured data are available for statistical processing.
- This is suitable for run-out measurement and cylindricity measurement.

5) Sample measurement

- A measurement where the number of samples is set to “2~999” is called a “sample measurement”.
- In practice this will take place as a single-run measurement or a continuous-run measurement.
  From the measured data the calculation items (mean, maximum value, minimum value, and range) that have been set for the sample measurement will be calculated and the resulting data will be automatically subject to GO/NG judgment. In addition, the measured data will be outputted for the RS-232C interface, Digimatic Output Unit interface, and printer.
- The measured data are available for statistical processing.
- This is suitable for run-out measurement and cylindricity measurement.

6) Statistical processing

- Measured data from single-run and continuous-run measurements can be statistically processed (i.e. the number of measurement times, standard deviation, maximum value, minimum value, mean, and range are calculated).
  These statistical processing results can be outputted for the display, printer (statistical memory for all programs will be cleared after printout), and RS-232C interface.
- Press the [STAT]/[S.E] key (or input “ST” command via the RS-232C interface) to start statistical processing, and press it again (or input the “NST” command via the RS-232C interface) to terminate statistical processing.
- Press the [A.CL]/[M.CL] key to clear the statistical memory of the foreground program (case of a simultaneous measurement), and press the [SHIFT] and [A.CL]/[M.CL] keys to clear the statistical memory of all the programs.
- These statistical results data will be stored in memory while the power is on, and will be lost when the power is turned off.

3.2 Techniques and Terminology of Setup Functions

3.2.1 Program

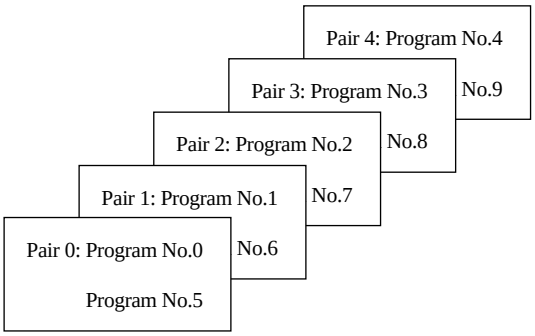
- A measurement will automatically be performed according to the registered (programmed) contents including the segment (feature to be measured) and GO/NG judgment criteria, etc., in advance. Registration is performed in the function setup mode.
- This unit can hold a maximum of 10 programs, which may include various settings suitable for up to ten kinds of workpieces.
- The user can select, in the basic setup, whether these ten programs are used as individual programs (referred to as “single measurement”) or as five pairs of programs (referred to as “simultaneous measurement”).

  a) Single measurement

  One session of measurement is performed according to the one specified program. This is the factory default.

  b) Simultaneous measurement

  - In one measurement session two programs are executed at one time as a pair. These pairs are formed as shown in the figure below.
  - To run a pair of programs, either of the two can be specified via numeric keys [0] to [9] and the one specified is called “foreground” program, and its counterpart is called “background” program.



3.2.2 Basic setup

- This is used to customize the basic setup conditions, including the resolution, available functions, and interface conditions, according to the measurement requirements.
- This basic setup must be performed at the beginning of a measurement. Note that changing the setup of resolution, or simultaneous measurement in this basic setup cancel the existing calibration values and function setup.
- The basic setup mode is entered by turning on the power while holding down the [SET] key.

  Note that no response will be made to RS-232C in the basic setup mode.
- For more information, refer to Section 4.1, “Basic Setup”.

3.2.3 Function setup

- Use this procedure to set up the conditions necessary for measurement.
  For each program number register measurement conditions including the segment (part feature to be measured), measurement interval (measurement time), and GO/NG judgment criteria that are the best suited for the objective workpiece.
- To enter the function setup mode press the [SET] key in the ready state. Each of the [LIMIT], [SHIFT]+ [MASTER]/[OFFSET], and [REF] keys allows the individual setup item to be established, and the [<] key enters the setup operation for items which are most frequently accessed for set up.
- For more information refer to Section 4.5, “Setting Up the Functions”.

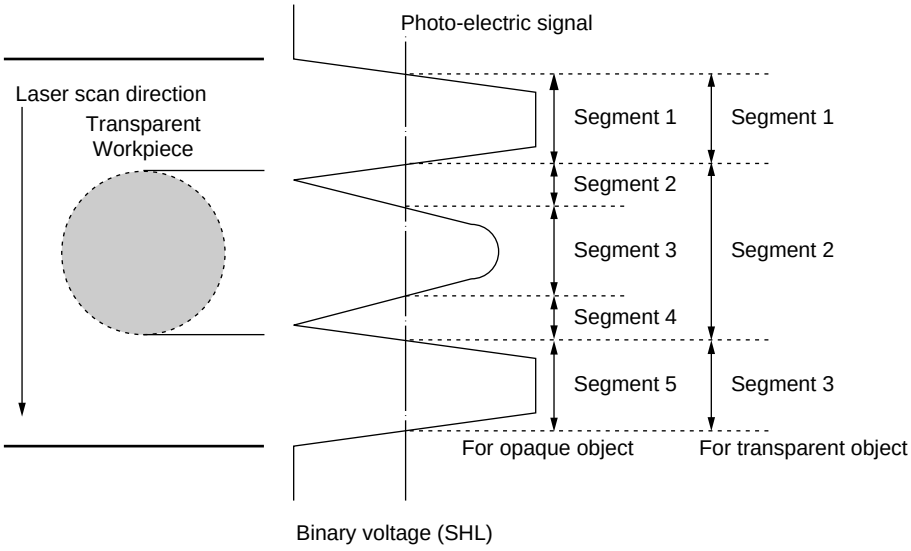
3.2.4 Setups according to the property of each workpiece

For measuring workpieces that transmit light or have a dimension smaller than the diameter of the scanning beam it is critical to make setups that take into account the properties of the workpiece.

3.2.4.1 Transparent object (Workpiece that transmits light)

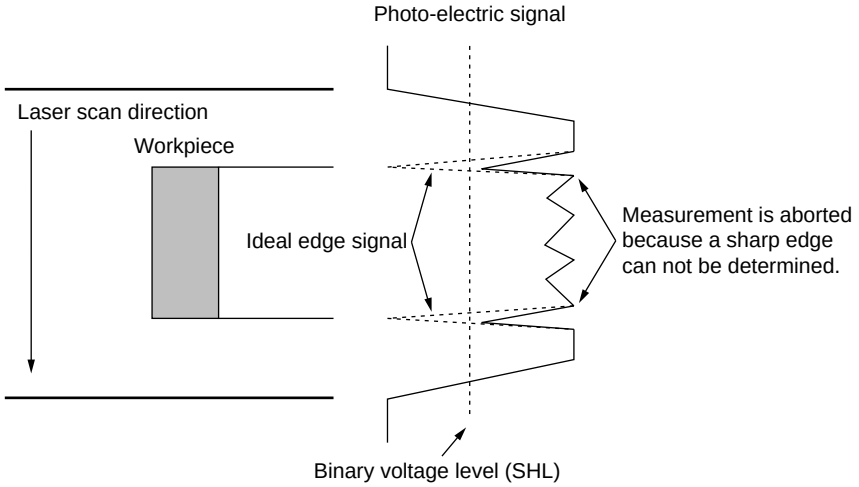
a) Round bar

- Workpieces such as fiber optics and glass tubes are more or less transparent, while workpieces made of steel are not. This requires different segment settings.
  The segment settings for an opaque object and a transparent object are as follows:
- Setup for measurement of transparent or opaque object is possible in the basic setup.



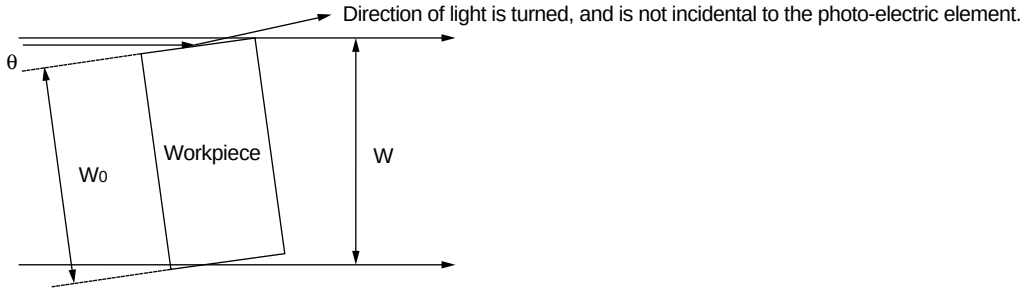
b) Plate (Sheet)

- If the workpiece being measured is a transparent plate (sheet) with edges that are not chamfered or beveled, there may not be a sharp contrast in the amount of light at the transition from the highlighted portion to the shaded portion. As a result, the voltage generated by the incident light on the photo-electric element can not reach the threshold voltage level (SHL), and Segment 2 is determined to not exist (Err-0).

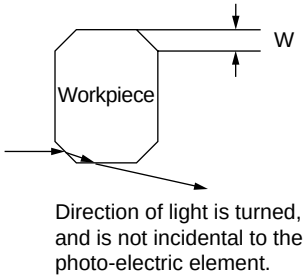


- For measuring a transparent plate-shaped workpiece
  Take the following precautions:

  1. Incline the workpiece.
  By inclining the workpiece it is possible to attain a sharp edge from the light contrast. In this case:
  Measurement : $W = W_0$ (workpiece dimension) x $\cos \theta$



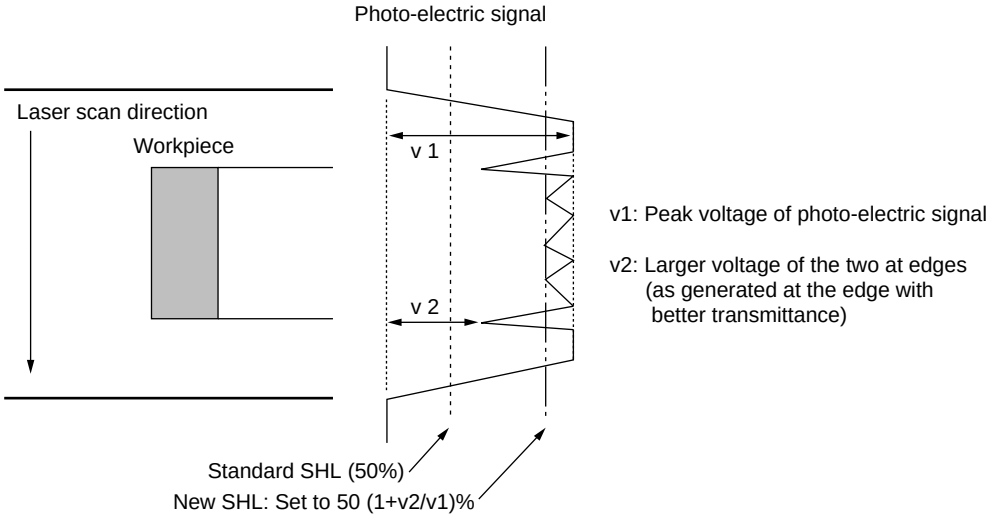
  2. Chamfering
  Chamfer the workpiece edge by W. Be sure that W will be larger than 0.4 mm.



3. Change the SHL

Change the standard SHL (50%) of the photo-electric signal generated.
The SHL can be changed in a range between 50% and 90%. First place a reference workpiece in the measuring region and connect the oscilloscope probe to the SCAN SIG connector located on the rear panel of the Main Unit. Observe the signals. Set the SHL to the center of the waveform that corresponds to the shadow from the smaller edge.

- This modification should be performed by sending the appropriate command to the RS-232C, as follows.
  "SHL75" ... Set the SHL to 75%.
  "SHL50" ... Set the SHL to 50%, which is standard.
- For more information, refer to Sections 4.5, "Setting up the functions" and 6.1.9, "Details of command descriptions".
- If the SHL has been modified, perform calibration again.
- With the width measurement of transparent film tape for example, measurements results may have a certain degree of dispersion. Therefore, it is recommended that a comparison measurement be performed using a reference tape.

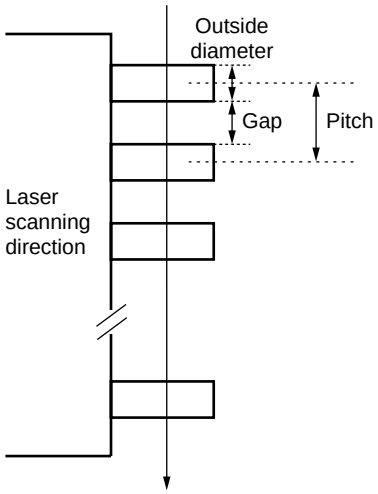


3.2.5 Latch (holding) of the displayed value

- In a single-run measurement, etc., GO/NG judgment will be continued while the measured data is latched (held) on the display for the specified period of time. After the set period elapses, system operation returns to the ready state.
- Set up the display latch timer in the basic setup.
- While the display is being latched, input from the RS-232C is still valid.

3.2.6 Automatic measurement with an edge specification

- If the edge specification is made, it is possible to automatically measure IC or connector leads with respect to their pitch (even intervals), outside diameter, or gap. This is suitable for inspecting the IC lead bend, etc.



- This function is only in effect if the necessary setups are made for edge specification in the basic setup.
- In the function setup designate whether automatic measurement should be performed (for pitch/outside diameter/gap measurement) or not (manual measurement). Also designate both the start and finish edges.
- This is available in combination with automatic workpiece detection.
- If automatic measurement has also been selected, the following will take place.

  a) In the ready state the first objective portion of the workpiece to be measured will be displayed.

  b) Automatic measurement will be involved in a single-run measurement or continuous-run measurement.
  If “Err-0” (insufficient number of edges to be measured) is detected, the measuring operation is stopped for the single-run measurement, and the collected measured data is cleared for continuous measurement to wait for a proper workpiece to be loaded.

  c) If the measured data is found to be ±NG, the first source of the ±NG will be displayed and the measuring operation is stopped. If GO results, the mean of all measurements is displayed.

  d) In the ready state, the first objective portion of the specified automatic measurement item will be displayed.

  e) If the measured data falls within the range of GO, the elapsed measurement time was as follows:
  (Number of measurement edges) x (measurement interval) + (calculation time: 20 ms)

  f) The W.P. LED shows the current portion of the workpiece being measured.

3.2.7 GO/NG judgment

- All the measured data are subject to GO/NG judgment.
  To enable, set the GO/NG judgment criteria in advance.
- The following settings can be made in the basic setup.

  a) The method of tolerance judgment can be selected from (Lower limit value and upper limit value), multi-limit selection (7 limits) and (Target value and tolerance values: upper tolerance value and lower tolerance value).
  The judgment result with the multi-limit selection will be outputted via RS-232C interface.

  b) Simultaneous measurement can be specified. The judgment result will be outputted via RS-232C interface.

  c) For (Target value and tolerance values), the user is permitted to select whether the target value is to be copied to the reference value. If it is, the setup guidance for the reference value will not appear.

  d) Even in the ready state it is possible to select whether tolerance judgment is performed. However, this data is not available for statistical processing.

  e) Abnormal data elimination, tolerance judgment, group judgment, and analog output can be performed in a single-run measurement, zero-run measurement, sample measurement, and continuous-run measurement. The judgment result will be indicated by the -NG (red LED), GO (green LED), and +NG (red LED) indicators and outputted to the RS-232C (including printer) interface.

  f) The following tables show the relationship between the measured data and tolerance judgment method

  1) (Lower and upper limit values)

GO/NG judgment	Measurement (judged if both the lower and upper limit values are set)
-NG	Measurement < Lower limit value
GO	Lower limit value ≤ Measurement < Upper limit value
+NG	Measurement ≥ Upper limit value

  2) (Target value and tolerance values)

GO/NG judgment	Measurement (judged if the target value, lower tolerance value and upper tolerance value are set)
-NG	Measurement < (Target value + lower tolerance limit)
GO	(Target value + lower tolerance value) ≤ Measurement < (Target value + upper tolerance value)
+NG	Measurement ≥ (Target value + upper tolerance value)

3) If all limits from L1 to L6 are set for multi-limit selection

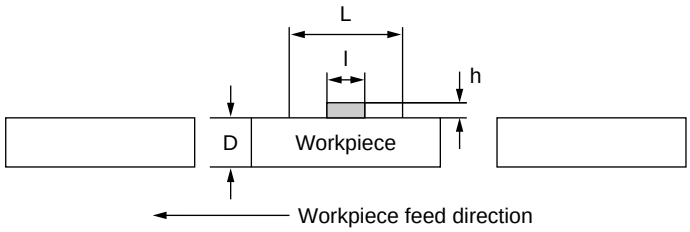
Multi-limit selection output	GO/NG judgment	Measurement from L1 to L6 are set.
L1	-NG	Measurement < L1
L2	GO	L1 ≤ Measurement < L2
L3	GO	L2 ≤ Measurement < L3
L4	GO	L3 ≤ Measurement < L4
L5	GO	L4 ≤ Measurement < L5
L6	GO	L5 ≤ Measurement < L6
L7	+NG	L6 ≤ Measurement

4) If only L1 and L2 are set for multi-limit selection

Multi-limit selection output	GO/NG judgment	Measurement Only L1 and L2 are set. (Judgment will not be performed if only one stage is set.)
L1	-NG	Measurement < L1
L2	GO	L1 ≤ Measurement < L2
L3 ~ L7	+NG	L2 ≤ Measurement

3.2.8 Abnormal data elimination

- The abnormal data elimination function eliminates measurements that are very different from those specified for the machined workpiece, from the measurement data (neither the measurement is displayed nor is data output performed).
  If, for example, the grindstone of a centerless grinder is controlled based on the measured data from the LSM, it is possible that a large measurement error may be created due to the coolant used with the workpiece.
  As shown in the figure below where foreign matter (with a height of h) adheres to within the averaging region L of the workpiece (with a diameter of D). An abnormal outside diameter results in the region of l and the displayed measurement will be (D + lh / L). As the result the grinder is subject to improper control that involves some error.



  Because the use of this function can eliminate abnormal measurement data generated due to the adhered foreign matter, the grindstone can be controlled and fed properly.

- Judgment of valid data or abnormal data will be performed at each measurement interval. Valid data includes those satisfy the following relation: Lower abnormal limit (Measurement) < Upper abnormal limit. All other data will be discarded as abnormal data.

- The following table shows the relationship between measurements and upper and lower abnormal limits.

Eliminate/Do not eliminate	Measurement (Judged if both the upper and lower abnormal limits are set.)
Eliminate	Measurement < Lower abnormal limit
Do not eliminate (accepted as a measurement)	Lower abnormal limit ≤ Measurement < Upper abnormal limit
Eliminate	Measurement ≥ Upper abnormal limit

- In the basic setup select whether this abnormal data elimination function should be used. If it is the setting of (lower abnormal limit and upper abnormal limit) should be performed before actual tolerance judgment.

- Abnormal data elimination function effects in single-run and continuous-run measurements.

- If “Err-0” (specified workpiece not present) is displayed in the sample measurement, the valid data collected will be discarded.

3.2.9 Offset/Zero-set

This function is used to measure the difference between the workpiece and the reference gage or to measure the workpiece that is larger than the measuring range of the LSM.

a) Offset

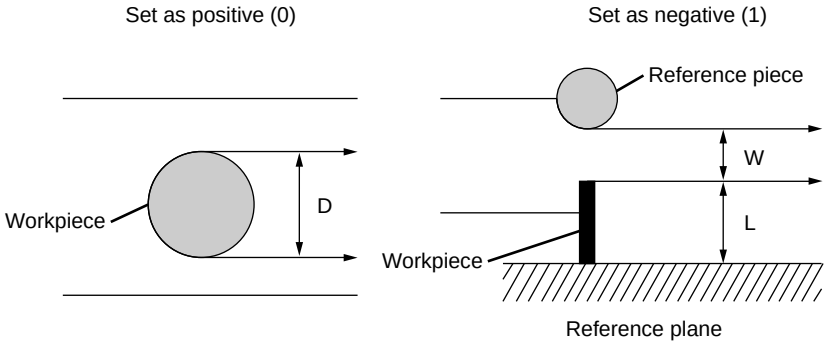
- In this system the operation of setting the reference gage dimension is called the offset operation.
- This function is applied to measure the absolute dimension of a workpiece.

b) Zero-set

- Setting the reference gage dimension to “0.0” for the purpose of comparing it with a workpiece dimension is called the zero-set.
- This function is applied to measure a deviation from the reference gage dimension.

c) Direction

Depending on the objective portion of measurement of a workpiece, the positive direction (set as “0”) or negative direction (set as “1”) must be set.
If, for example, the shaded portion of D in the following diagram is measured, the direction must be set as positive (0). If the highlighted portion (gap) of W is to be measured for determining the workpiece dimension L, the direction must be specified as negative (1).



- Offset operation takes about 1 second to determine the compensation value by measuring the reference gage.
- Offset value will be ineffective if the segment or edge number is changed (Offset value is unique to each segment or edge).

3.2.10 Mastering

- If the objective workpieces are high-precision gages that are machined successively, the above described offset/zero-set values may need to be fine-adjusted to the master. This fine-adjustment is called mastering.
  After mastering, the total compensation value will be:
  (Offset value/zero-set value) + (±Mastering value)
  Setting a positive (+) mastering value allows the measurement of a workpiece OD to be greater than the raw measurement, and setting a negative (-) mastering value allows the measurement of a workpiece OD to be smaller than the raw measurement.
- Because no measurement is required for this mastering, the reference gauge is not required either.
- Mastering will be cancelled if subjected to offset/zeroset.
- Set the reference gage dimension with the offset function and perform mastering.

3.2.11 Reference value

- In the basic setup the following conditions can be set.
  a) Whether the target value of GO/NG judgment is being copied to the reference value. If this is selected, the setup guidance for the reference value will not be displayed.
  b) It is also possible to set so that tolerance judgment can take place in the ready state.
- If the reference value is being set the deviation value (Measured data-reference value) will be output for the RS-232C interface and the printer if single-run measurement or continuous-run measurement is performed.

3.2.12 Data output conditions

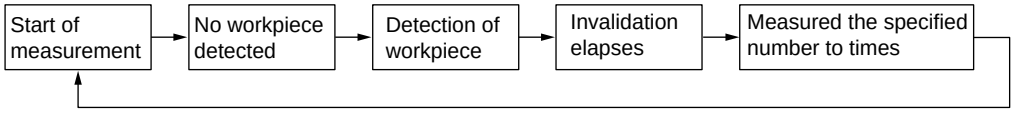
- In single-run measurement or continuous-run measurement, measured data can be outputted for each measurement if ±NG occurs, or at given intervals to the RS-232C interface, printer, or Mitutoyo Digimatic Output Unit interface.

Data output condition	RS-232C DCU	Printer	Remark
0	—	—	
1	—	○	The periodical output timer can be set
2	—	△	
3	○	—	The periodical output timer can be set
4	△	—	
5	○	○	The periodical output timer can be set
6	△	△	
7	—	□	
8	□	—	
9	□	□	

○ : Outputted for each measurement if RUN or CRUN key, etc., is pressed.
△ : Press the RUN or CRUN key to trigger the measurement. The measured data will be outputted if it falls on GO.
□ : Press the RUN or CRUN key to trigger the measurement. The measured data will be outputted if it falls on ±NG.
— : No output will be made.

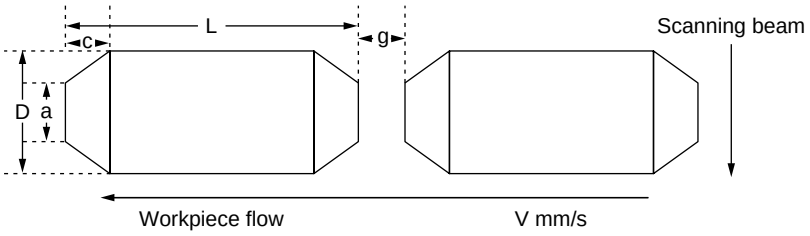
3.2.13 Automatic workpiece detection <OD detection method, Position detection method>

- Automatic workpiece detection is performed for continuous-run measurement, where measurement starts with no specified workpiece present (Err-0), then proceeds to automatic detection of the workpiece, followed by measurement repeated number of times. No specified workpiece present (Err-5) also refers to the workpiece outside the upper and lower detection limits.
- Whether automatic workpiece detection is performed is specified in the basic setup mode. If automatic workpiece detection is specified, the number of scanning times for detection must be specified from among 1 and 16. Select 16 times if detecting precision workpieces. If automatic workpiece detection is not specified, no further setting is necessary.
- Automatic workpiece detection setup includes the number of measurement times, invalidation period, upper and lower detection limits. Both the upper and lower detection limits may not always need to be specified, however, they should be set for safety.
- To exclude the measured data of such as chamfered portion of the workpiece, invalidation period can be set within the range from 0.001 sec to 9.999 sec.



1) OD detection method

- This is used to automatically detect a workpiece that enters the laser scanning plane perpendicularly.
- For actual detection of a workpiece the displayed measurement (after calibration and offset) is used.
- One session of automatic detection consists of no workpiece being detected, detection of a workpiece with a dimension that is within the detection range (between the upper and lower detection limits), an invalidation period required to exclude invalid dimensions (of chamfered portions, etc.) from the measurement, and effective measurement for the specified number of times. The final measurement result will be latched (held) on the display. Once entering the effective measurement the upper and lower detection limits will no longer be checked.
- The speed of workpiece detection (i.e. the number of scans) can be specified as either 1 or 16 in the basic setup.
- Use 16 times in the following cases:
  * If connecting bars are used between workpieces for feeding convenience and for setting appropriate intervals between workpieces, and, if the difference in the outside diameter between the workpiece and the bar is insufficient.
  * If the feed rate is low.
- The following diagram is an example where a workpiece with a chamfered outside diameter of D mm and a length of L mm moves at a velocity of V mm/s.

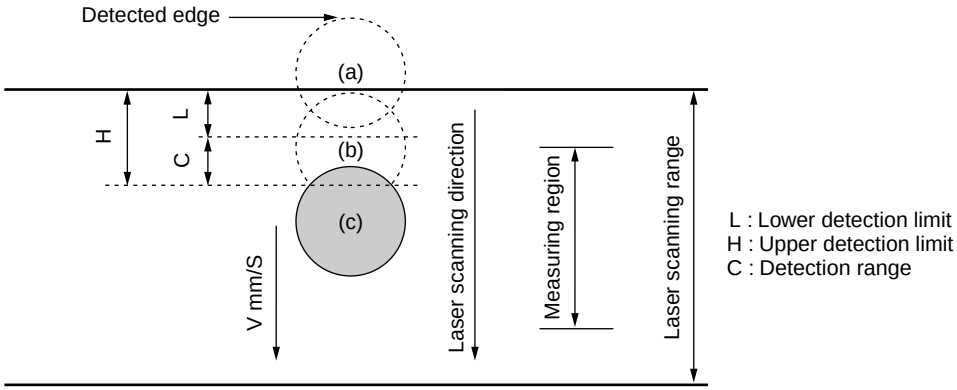


Setting example:

- Lower detection limit: L < (a +D) / 2
- Upper detection limit: H > Upper limit of the measuring range or 1.1 D (This setting may be omitted.)
- Invalidation period : T > (c / V) ms
- Number of measurements: N < (L - 2c) x 0.8 (safety factor) / measurement interval

2) Position detection method

- This is used to automatically detect a workpiece that enters the measuring region in the laser scanning plane in the same direction of the scan.
- Workpiece detection is performed with one scan, and 16 scans can not be specified (If specified in the basic setup, the specification will be ignored).
- One session of automatic detection consists of the detection of no workpiece, detection of a workpiece edge with a dimension that falls within the detection range (between the upper and lower detection limits), an invalidation period required to exclude invalid dimensions from the measurement, and effective measurement for the specified number of times. Once the effective measurement has been entered, the upper and lower detection limits will no longer be checked.
- In the following diagram, workpiece positions (a) and (b) result in no workpiece being present, and in (c) it is judged that a workpiece is present.



Setting example:

Assuming the workpiece diameter as D (mm) and the moving speed as V (mm/s):

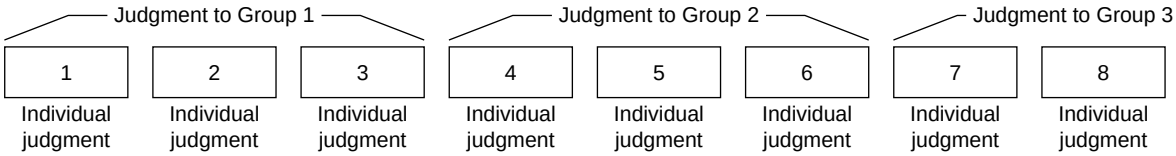
- Lower detection limit: L > (Laser scanning range - measuring region) / 2
- Upper detection limit: H < (Laser scanning range + measuring region) / 2 - D (This setting may be omitted.)
- Invalidation period : Generally set to 0 ms.
- Number of measurements: N = 1

NOTE

- Allow a sufficient margin for the lower detection limit, upper detection limit, invalidation period, and number of measuring times when setting them. If this surplus is not sufficient, the measurement may not be achieved.
- If using the sample measurement, specify the number of measuring times to 1.
- The automatic workpiece detection functions in the continuous-run measurement.

3.2.14 Group judgment

- While the tolerance judgment is applied to each measurement from a workpiece, this group judgment is applied to a group of the specified number of workpieces.



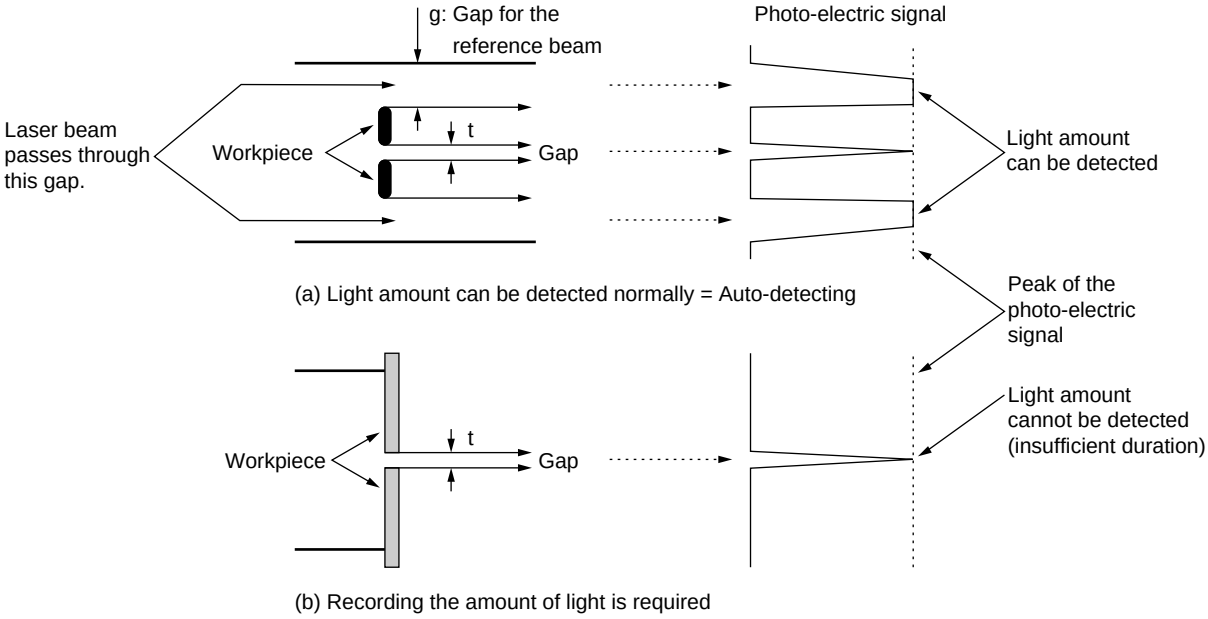
- In the basic setup select whether group judgment is to be performed. If it is, then set the group size (the number of workpieces included in a group), calculation items (mean, maximum value, minimum value, and range), and group lower limit and upper limit. If "Not performing group judgment" is selected, the setup guidance for it will not be displayed.
- The group judgment will be in effect in a single-run measurement or continuous-run measurement.
  a) For the result display and GO/NG judgment indication each individual measurement and judgment result will be used.
  b) RS-232C output
     In the basic setup it is possible to set whether the group judgment result data is outputted for the RS-232C interface. If it is, the output contents from the group judgment will be as follows:

```
P0,    ( GO)   12.34567 ... Individual data
P0,    ( GO)   12.34560 ... Individual data
P0,    (+NG)   12.34600 ... Individual data
GP0,   ( GO)   12.34575 ... Group judgment result data
```

- Each individual piece of measurement data can be the objective of statistical processing, however, group measurement data will be excluded from statistical processing.
- Even if "Err-0" (specified workpiece not present) occurs, the obtained data will not be cleared. To abort the measurement, press the [C] key (or input the "CL" command via the RS-232C interface).

3.2.15 Recording the amount of light

- The gap measurement may be unstable if not enough laser beam passes through the gaps. In the case shown in diagram (a) below, an adequate amount of light can be obtained as the laser passes through gap (g) above the workpiece, even if the gap (t) is small. However, in diagram (b) where gap (t) is small, measurement will be affected. In this case, therefore, it is necessary to have the system record the full amount of light when there is no obstruction (workpiece or fixture) in the optical path.



(a) Light amount can be detected normally = Auto-detecting

(b) Recording the amount of light is required

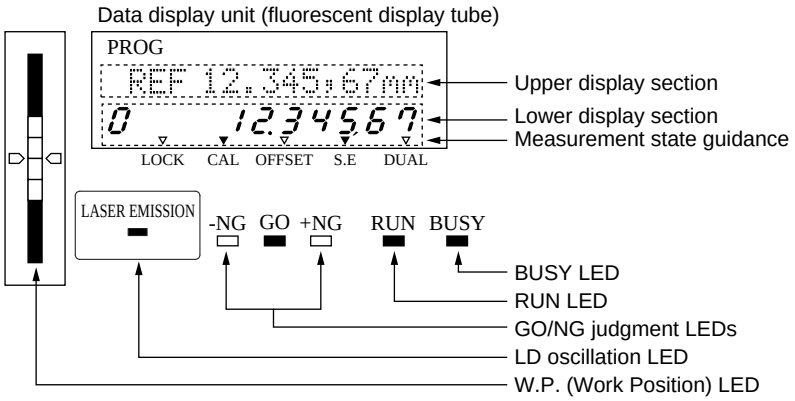
- Normally the amount of incident light is continuously checked so that the counting operation can follow the change in the amount of incident light. The minimum size of gap “g” or “t” is 2 mm. Have the system record the light amount following 4.4, “How to read-in the amount of light”. It is also necessary to carry out this operation twice or three times each year since the light amount of the system may vary.

3.3 Outline of the Display Contents

Displays of this system are effected by the display unit and guidance LEDs.

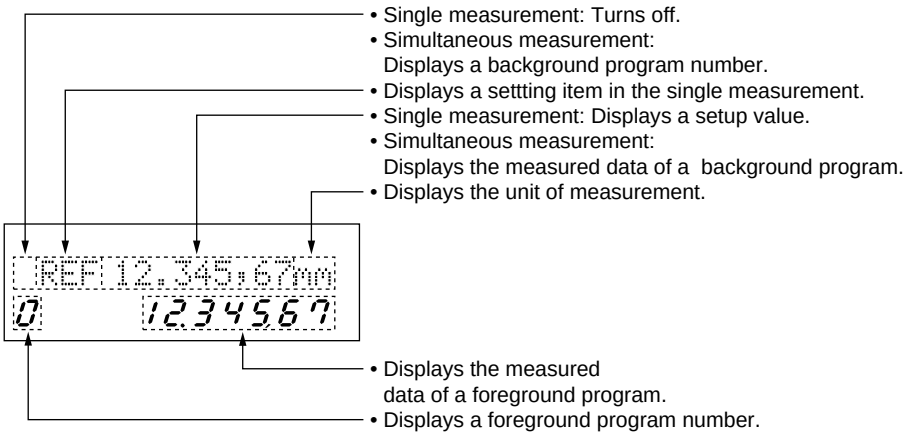
3.3.1 Display unit

The name of each part of the display unit and the LEDs are given below:



3.3.2 Data display unit

1) Numeric and character display



2) Operation state guidance

- LOCK: Turns on in the key lock state, which is initiated by pressing both the SHIFT and LOCK/UNIT keys. If these keys are input the key lock state will be canceled.
- CAL: Turns on if the calibration (HI CAL) is specified.
- OFFSET: Turns on if the offset function is active.
- S.E: Turns on if statistical processing is activated.
- DUAL: Turns on if simultaneous measurement is specified.

3) Display LED

- W.P. (Work Position) LED
  LED segments corresponding to a region shaded by the workpiece, which blocks the laser beam, will turn off. This is used to check if the workpiece is located in the center of the measuring region.
- LD oscillation LED
  LASER EMISSION : Indicates that the laser in the Measuring Unit is oscillating.
- GO/NG judgment LED
  1. -NG : Turns on if the measured data is -NG.
  2. GO : Turns on if the measured data is GO.
  3. +NG : Turns on if the measured data is +NG.
- RUN LED
  Turns on if a single-run measurement or continuous-run measurement is performed.
- BUSY LED
  Turns on each time the measured data is updated.

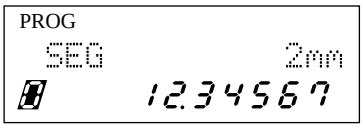
IMPORTANT Laser safety

For safety, the laser will not turn on until 5 seconds after the power is turned on. If the power is unintentionally turned on, turn off the power within 5 seconds to secure the laser.

3.4 Outline of Key Operations

On this system operate the keys as follows.

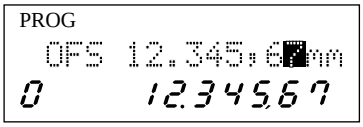
- The [STAT]/[S.E] key, for example, has two functions as indicated on the upper and lower portions of the key top. The function on the upper portion can be activated by simply pressing the key, and the one on the lower portion can be activated by pressing the key while holding down the [SHIFT] key. If the [SHIFT] key is pressed, the currently displayed program number flashes for about 10 seconds until another key is pressed. During this period one of the functions in the upper portions of the keys can be selected. Press the [STAT]/[S.E] key while the program number is flashing.



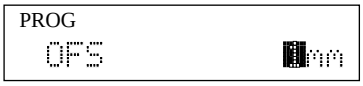
- To enter the reference gage values, such as HIGH CAL, LOW CAL and offset, or other setup values such as reference values and GO/NG judgment criteria, etc., the numeric keys ([0] to [9], [.], [+/-]) and arrow keys ([<], [>], [∧] and [∨]) can be used.

a) If a setup value entry is started with a numeric key and an arrow key is pressed halfway, an operation error will result. The following example shows a case of an offset value.

1. Enter the setup mode of the offset function.
   The least significant digit of the existing offset value is flashing.



2. Change the value to 12.00 mm.
   Press the [1] key.

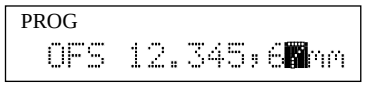


3. If an arrow key is pressed at this point, an operation error occurs, however the display does not change.

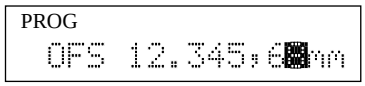
4. To enable the entry of an arrow key, press the [C] key to cancel the setup value.
   Now the arrow keys are operable.

b) If a measurement is read as the setup data by pressing the READ key or if the entry of a setup value is started with an arrow key and a numeric key is pressed halfway an operation error will result. See the example above.

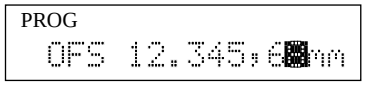
1. Enter the setup mode of the offset function.
   The least significant digit of the existing offset value flashes.



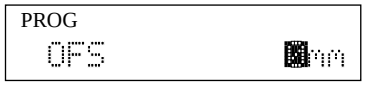
2. Enter the ∧ key.



3. If a numeric key is pressed at this point, an operation error occurs, however the display does not change.



4. To enable the entry of a numeric key, press the C key to cancel the setup value.
   Now the numeric keys are operable.



3.4.1 Description of key functions

Key name	• In the ready state • In the display-latched state	• At single-run measurement • At continuous-run measurement	• At setup • Combined use with power-on operation
[0] ~ [9]	• Changes the program number	• Operation error	• Enters the setup data.
[•]	• Operation error	• Operation error	• Enters a decimal point.
[+/-]	• Operation error	• Operation error	• Inverts the sign of the setup value.
[C]	• Cancels the error that occurred when the power was turned on. • Cancels the latched state and returns to the ready state.	• Aborts the measurement and returns to the ready state.	• Cancels the setup value or resets it to initial value. • Cancels the error state. • [C] + power-on will enter the initialization mode of the Display Unit.
[SHIFT]	• Shift key To enter the function indicated in the upper portion of a double-function key, such as the [STAT S.E] key, hold down the [SHIFT] before pressing the key. • A foreground program number will flash for about 10 seconds.	• Operation error	• Entry of [SHIFT] + [READ] (to set the light amount detecting function) is valid when the function setup item number flashes in the function setup mode.
[RUN]	• Performs single-run measurement (even in the display-latched state).	• Results in a single-run measurement error. • Quits the measuring operation for continuous-run measurement.	• Operation error
[C.RUN]	• Starts continuous-run measurement (even in the display-latched state).	• Quits the measuring operation for continuous-run measurement (same as [RUN]).	• Operation error
[S.PR PRINT]	• Prints out the previous measurement data. • Prints out the data currently displayed in the display-latched state.	• Results in a single-run measurement error. • Prints out the previous measurement data in continuous-run measurement.	• Operation error
[SHIFT] [S.PR PRINT]	• If the printer is active, prints out all the statistical processing data and clears the statistical memory. • If the printer is not active, results in an operation error.	• Operation error	• Operation error

Key name	• In the ready state • In the display-latched state	• At single-run measurement • At continuous-run measurement	• At setup • Combined use with power-on operation
SET	• Enters the function setup mode.	• Operation error	• Exits from the function setup mode and returns to the ready state. • Enters the state that is entered just after the power is turned on, if in the basic setup mode. • SET + power-on is used to enter the basic setup mode.
LIMIT	• Directly enters the setup mode for GO/NG judgment.	• Operation error	• Press ENT to complete the setup operation and return to the ready state. • Press LIMIT or SET to abort the setup operation and return to the ready state.
MASTER OFFSET	• Performs zero-setting (in the positive direction) if an offset value is not set. • If an offset value is set, executes the offset function with the offset value being set. • Update of the setup data for the offset function must be performed in the function setup mode.	• Operation error	• Operation error
SHIFT + MASTER OFFSET	• Directly enters the setup for mastering. • If no offset value is set, an error results.	• Operation error	• Press ENT to complete the setup operation and return to the ready state. • Press MASTER OFFSET or SET to abort the setup operation and return to the ready state.
REF	• Directly enters the setup operation for the reference value. • If "Copying the target value to the reference value" is specified in the basic setup, the setup guidance will not be displayed.	• Operation error	• Press ENT to complete the setup operation and return to the ready state. • Press REF or SET to abort the setup operation and return to the ready state.
ENT	• Operation error	• Operation error	• Accepts the setup data that is pressed.

Key name	• In the ready state • In the display-latched state	• At single-run measurement • At continuous-run measurement	• At setup • Combined use with power-on operation
STAT S.E	• Enables/disables statistical processing. • If statistical processing is active, measurement state guidance (▼) for statistical processing turns on.	• Operation error	• Operation error
SHIFT STAT S.E	• Enters the statistic display mode and displays N in the statistical memory. • Each time the ENT key is pressed S.D, MAX, MIN, AVG, R, and N are sequentially displayed. • Press STAT S.E or SET to restore the ready state.	• Operation error	• Operation error
A.CL M.CL	• Enters the clear mode of the statistical memory for the specified program number. • Press ENT to execute clear, and pressing A.CL M.CL or SET to abort the clearing operation and return to the ready state.	• Operation error	• Operation error
SHIFT A.CL M.CL	• Enters the clear mode of the statistical memory for all program numbers. • Press ENT to execute clear, and press A.CL M.CL or SET to abort the clearing operation and return to the ready state.	• Operation error	• Operation error
LOCK UNIT	• Enters the unit change mode. • Press ENT to execute a change of units, and press LOCK UNIT or SET to abort the unit change operation and returns to the ready state.	• Operation error	• Operation error
SHIFT LOCK UNIT	• Enters the key lock mode, turns on the measurement state guidance (▼) for the key lock function, then prohibits subsequent key inputs. • If these keys are pressed again in the key lock state, it will be canceled.	• Operation error	• Operation error

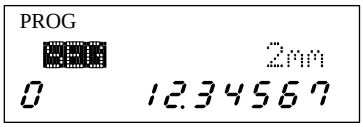
Key name	• In the ready state • In the display-latched state	• At single-run measurement • At continuous-run measurement	• At setup • Combined use with power-on operation
H.CAL	• Enters the HIGH CAL setup mode.	• Operation error	• (Input of gage diameter) + ENT executes HI CAL and illuminates the measurement state guidance (▼) for CAL. • Press H.CAL or SET in the HI CAL setup mode to abort the setup operation and return to the ready state.
L.CAL	• Enters the LOW CAL setup mode.	• Operation error	• (Input of gage diameter) + ENT executes LOW CAL. • Press L.CAL or SET in the LOW CAL setup mode to abort the setup operation and return to the ready state.
READ	• Operation error	• Operation error	• Reads the measurement of the reference gage as the setup value. • The read value can be modified with the < , > , ∧ , and ∨ keys.
SHIFT READ	• Enters the detection mode of the measurement position (focal position). • Press READ or SET to restore the ready state.	• Operation error	• If this entry is made when the function setup item number is flashing in the function setup mode, which was accessed by the SET key, the setup operation for the light amount detection is entered.
<	• This is used to enter the setup mode for the setup item that is being displayed in the upper section of the display unit.	• Operation error	• Move left key
>	• Operation error	• Operation error	• Move right key
∧	• Operation error	• Operation error	• Up key to increment the setup value.
∨	• Operation error	• Operation error	• Down key to decrement the setup value.

3.4.2 Example key operations

As an example operation this section uses an update of the tolerance limits which are displayed in the upper display section while in the ready state. Suppose that the new lower tolerance limit is “12.34500” and the upper tolerance limit is “12.34600” and that the current values are “12.00000” and “12.00100”.

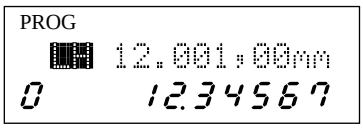
In the example below, we start with canceling existing upper and lower tolerance limits since the lower tolerance limit to be set is smaller than the existing upper tolerance limit. If this is the case, setting the lower tolerance limit first causes an error (ERR-5).

Step 1: In the ready state press the [<] key to make the setup item being displayed flash in the upper display section.

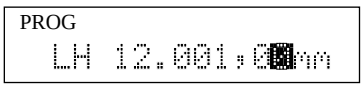


Each time the [∧] key is pressed, while the setup item is flashing, the setup item will change sequentially: Segment [redacted] → Measurement interval [redacted] → Offset [redacted] → Lower limit value [redacted] → Upper limit value [redacted] → Reference value [redacted] → Offset [redacted] → Mastering [redacted] → [redacted]
If the [∨] key is pressed, the setup item will change in the reverse order.
As the displayed setup items vary with the results of the basic setup, refer to Section 5.1.1, “Setup in the measurement mode”

Step 2: If the upper limit value is going to be canceled, make the [redacted] guidance flash.



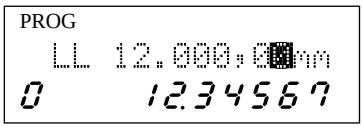
Step 3: Press either the [ENT] or [<] key to make the least significant digit of the setup data flash.



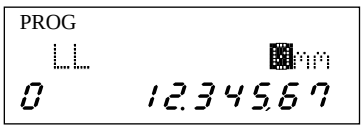
Step 4: To cancel the upper limit value press the [C] key to set the setup data to “0”.

Step 5: If the [ENT] key is pressed, the upper limit value is canceled and system operation returns to the ready state.

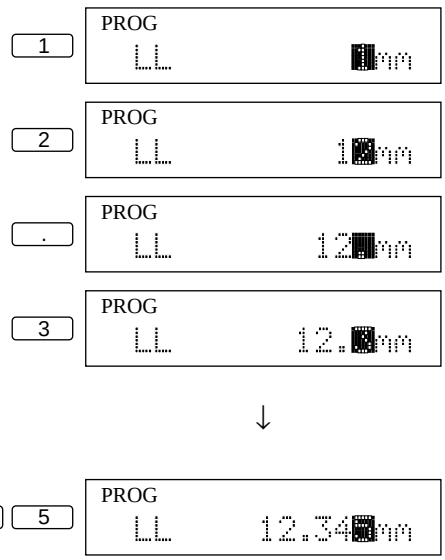
Step 6: After making the [redacted] guidance flash by pressing the [<] key, press the [∨] and [ENT] keys to enter the setup mode for the lower limit value.



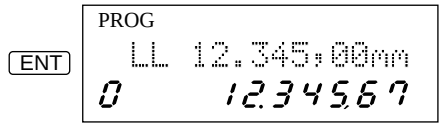
Step 7: Press the [C] key to set the display of the lower limit value to “0” (can be omitted), then enter a new lower limit value of “12.34500”.



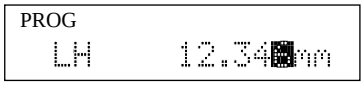
1) Each time the numeric key is pressed the corresponding digit will be placed in the position of the least significant digit, as shown in the figure on the right. In this example insignificant zeros (0 0) are not entered, they will be automatically added to fill the remaining digit places when the ENT key is pressed.



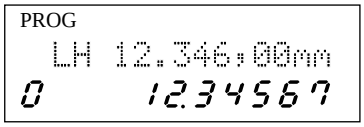
2) Press the ENT key to save the setup data of the lower limit value, and return to the ready state.
If "Inserting a comma (,) after the thousandth digit" is specified in the basic setup, it will be automatically inserted when the ENT key is pressed.



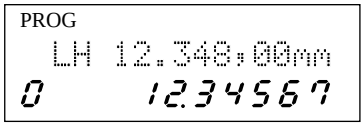
Step 8: As in steps 6 and 7, enter a new upper limit value.



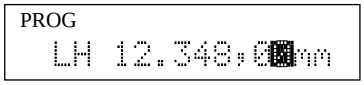
Step 9: If the ENT key is pressed, the setup data of the upper limit value is saved in memory, then operation returns to the ready state.



Step 10: Here, for practice, intentionally enter the incorrect upper limit value of "12.34800" then correct it.



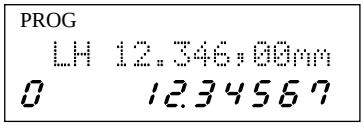
Step 11: Enter the setup mode for the upper limit value again.



1) Press the < key twice to make the third digit flash.

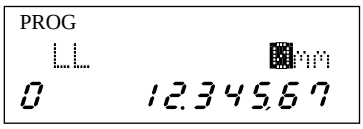
2) Press the ∨ key twice to change the third digit to "6".

3) Press the ENT key to save the setup data. The operation will be automatically return to the ready state.

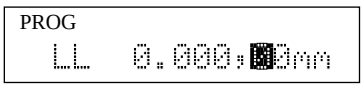


The following describes how to use the arrow keys using step 7 as an example.

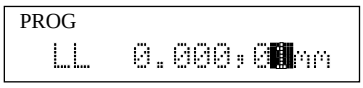
1) Now, the setup data of “0” is displayed as a result of having pressed the [C] key.



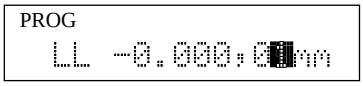
2) If the [<] key is pressed, the digit places are automatically filled with zeros to reflect the set resolution, with the appropriate number of commas inserted after the thousandth digit, then the highlighted digit moves one position to the left.



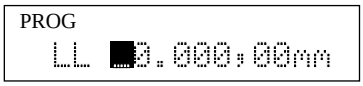
If the [∧] key is pressed, the digit places are automatically filled with zeros to reflect the set resolution, with the appropriate number of commas inserted after the thousandth digit, then the least significant digit increases by one.



If the [∨] key is pressed, the digit places are automatically filled with zeros to reflect the set resolution, with the appropriate number of commas inserted after the thousandth digit, then the least significant digit decreases by one, resulting in a negative value.



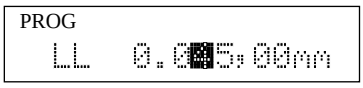
If the [>] key is pressed, the digit places are automatically filled with zeros to reflect the set resolution, with the appropriate number of commas inserted after the thousandth digit, then the most significant digit that can be set starts flashing.



Here, for practice, press the [<] key.

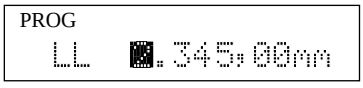
3) Press the [<] key twice to move the digit to be set to the third digit place, then press the [∧] key five times.

4) Press the [<] key to move the digit to be set to the forth digit place, then press the [∧] key four times.



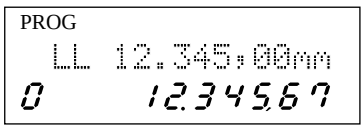
5) Press the [<] key to move the target digit to be set to the fifth digit, then press the [∧] key three times.

6) Press the [<] key to move the digit to be set to the sixth digit place, then press the [∧] key twice.



7) Press the [<] key to move the target digit to be set to the seventh digit place, then press the [∧] key.

8) Press the [ENT] key to save the setup value in memory.

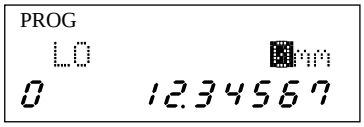


IMPORTANT Rounding setup value

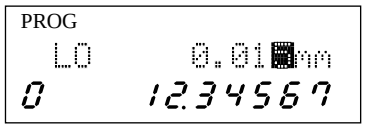
Setup value will be rounded off automatically if its least significant digit does not agree with the resolution of the display.
Example: In case the resolution is 0.05 µm
345,64 > 12.345,60 (least significant digit 4 is rounded off to 0)
345,67 > 12.345,65 (least significant digit 7 is rounded off to 5)

TIP About the input of setup data

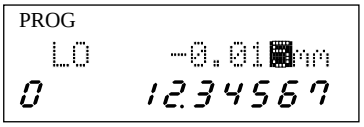
1. How to enter a sign
   If "Perform GO/NG judgment by (target value + tolerance)" has been specified in the basic setup and the lower tolerance limit is "-0.015", input as follows. In this case a "0" does not need to be placed in the integer section.



([0]) [.] [0] [1] [5]



[+/-]



2. [READ] key: About the read operation
   Generally, in the calibration or offset value setup operation a reference gage is used, resulting in a measured data that is very close to the setup value. If this is the case, first read a measurement as the setup data, then correct the minor difference.
3. To enter a numeric value such as a gage diameter, it is more convenient to use the numeric keys. To correct a specific digit, it is more convenient to use the arrow keys.
4. To select a setup item such as the resolution in the basic setup, it is better to use the [∧] or [∨] key. Use of a numeric key causes an operation error.

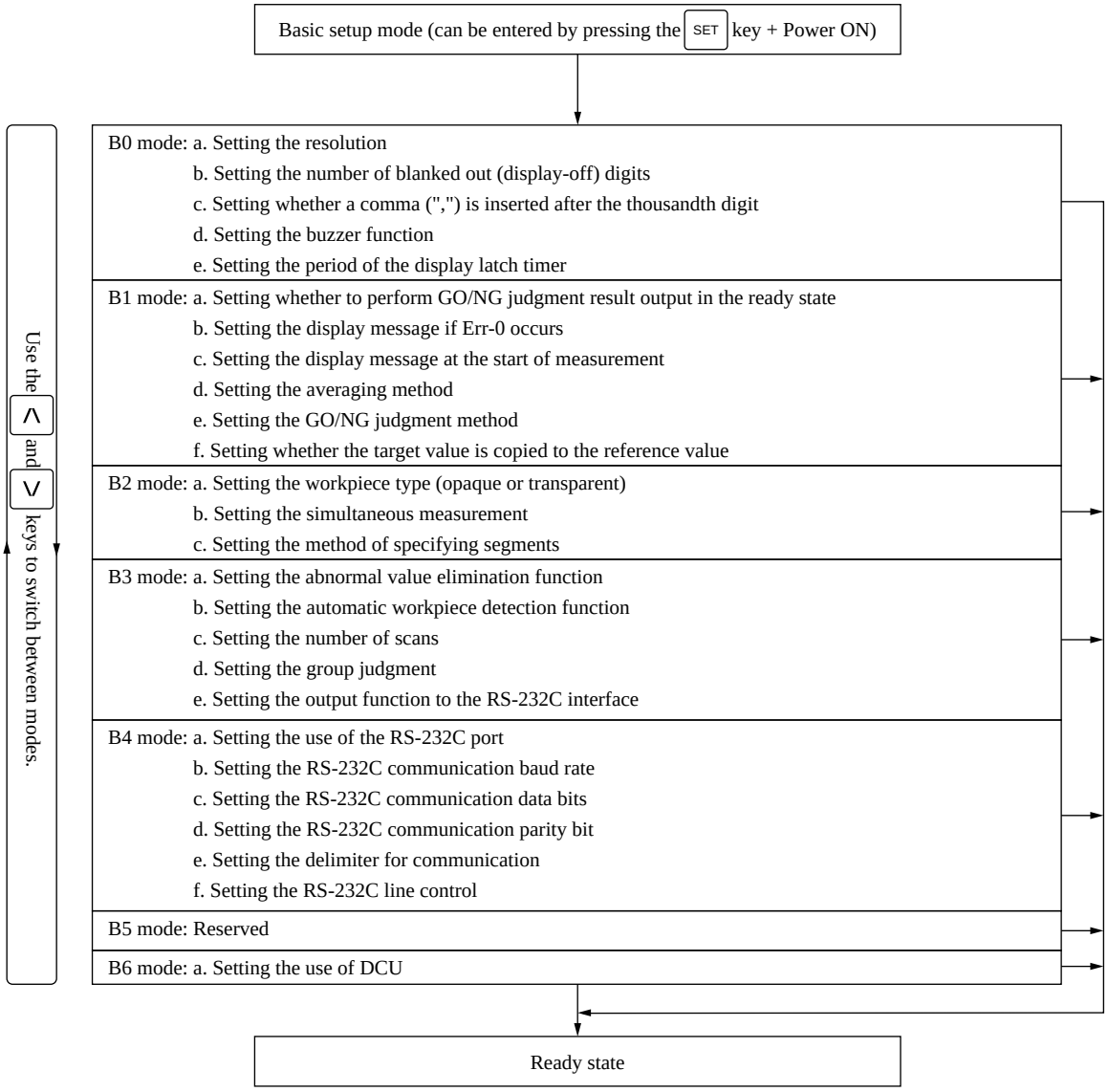
4 SETTING UP THE MEASURING CONDITIONS

Set up the various functions as required to customize the system for the utmost measurement accuracy.

4.1 Basic Setup

- In the basic setup mode select and modify the appropriate functions to meet your measuring purpose. It is not necessary to set up functions which will not be used.
- The basic setup should be performed at the beginning of operation.
  Modification of the basic setup after calibration or function setup has been made may result in the cancellation of the calibration or function setup values.
- Commands via the RS-232C interface can not be accepted in the basic setup mode.

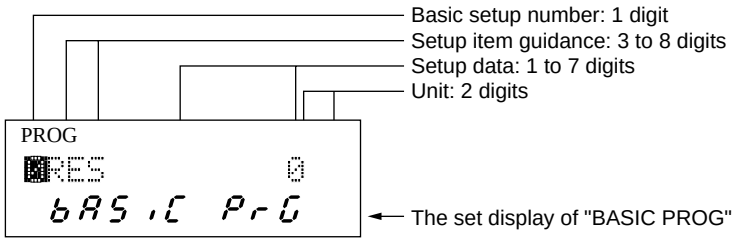
4.1.1 Outline of the basic setup procedure



4.1.2 Description of each mode

1. Data display unit

If the basic setup mode is entered, the following display appears.
The basic setup number "0" will be flashing in the most significant digit of the upper display section, and the guidance for the setup item, followed by the setup value, will be shown at the right of the setup number.
In the lower display section "bAS.C PrG" will be displayed.



2. Selecting the basic setup number

- Each time the [∧] key is pressed when the basic setup number is flashing the function setup number digit changes as follows: 0 → 1 → 2 → 3 → 4 → 5 → 6 → 7 → 0. To enter the desired setup mode press the [ENT] key when its setup number is flashing. If the [∨] key is pressed, the setup mode will change in reverse order.
- If a key other than [∧], [∨], [ENT], or [SET] is pressed during the selection of a basic setup number an operation error will result.
- When each piece of setup data is accepted with the [ENT] key in the corresponding setup mode, the operation will automatically proceed to the next setup item.

3. Setting each setup item

- Except for setting up the display latch timer, select the setup item using the [∧] or [∨] key and accept the setup specification by pressing the [ENT] key. When the setup content is accepted, the operation will automatically proceed to the next setup item. In setting the display latch timer, it is better to use the numeric keys rather than the arrow keys, which, however, are valid.

4. Confirming the setup contents of each setup item

To confirm the setup specification of each setup item use only the [ENT] key, which does not affect the setup specifications.

5. Terminating the basic setup mode

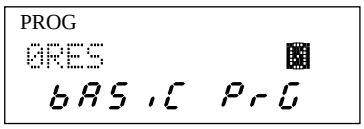
- If the [SET] key is pressed while the basic setup number is flashing, the setup contents modified in this session will be saved, and the system will restore the state that is entered just after the power is turned on.
- If the [SET] key is pressed in the setup mode of each setup item, the operation returns to the selection of a basic setup number. If the [SET] key is pressed again at this point , the setup contents modified in this session will be saved, and the system will restore the state that is entered just after the power is turned on.
- If the power is turned off halfway the setup operation, setup specifications made will not be saved. If this is the case, setup should be repeated from the beginning.

4.1.2.1 Selecting and setting the function in the B0 mode

a. Setting the resolution (Guidance: RES)

Set the resolution of the Measuring Unit. The resolutions that can be set for the Measuring Units are given in "Table 4.5.2.1A" and "Table 4.5.2.1B".

Step 1: Each time the [△] key is pressed the displayed setup option (number) changes in the following order: 0 → 1 → 2... → 6 → 7 → 0. If the desired option is flashing, press the [ENT] key. If the resolution setting has been made, the operation automatically proceeds to the setting for the number of blanked out digits.
The initial setup option is set to 0.



1. Resolution using the metric system (Unit: μm) Table 4.5.2.1A

Model name	0	1	2	3	4	5	6	7
LSM-9506	0.05	0.1	0.2	0.5	1	2	10	100

2. Resolution using the inch system (Unit: inch) Table 4.5.2.1B

Model name	0	1	2	3	4	5	6	7
LSM-9506	.000002	.000005	.00001	.00002	.00005	.0001	.0005	.005

Note 1: The shaded figures show the default setting of each Measuring Unit.
Note 2: Resolutions in the columns of " 0" show those which can be obtained from 32 scans.
Resolutions in the columns with " 1" show those which can be obtained from 16 scans.
Note 3: If the number of scans are set between 1 to 8, the least significant digit of a measurement will be automatically blanked out where resolution is set to No.0, 1, or 2.
Note 4: Note that setting a too large resolution may often reduce the measuring accuracy. Where the displayed digits are closely intact and difficult to see, set the number of blank-out digits or mark the thousandth digit function in the basic setup mode: b0.

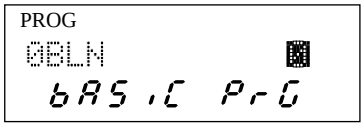
IMPORTANT Changing the resolution will cancel all the clibration values (HIGH CAL and LOW CAL), offset value, mastering, abnormal value eliminating limits, GO/NG judgment criteria, reference value, and setup values for the automatic workpiece detection. Therefore, changing of the resolution should be carried out first.

b. Setting the number of blank-out digits (Guidance: BLN)

Here, set the number of blank-out digits for measurements to be displayed in the display unit. This blank out does not apply to the output to RS-232C interface, printer, Digimatic output unit, and the display of setup value.

0 : No blank out (all digits are displayed) →12.34567
1 : The least significant digit is blanked out. →12.3456
2 : The least significant two digits are blanked out. →12.345
(Default setting is 0.)

Step 1: Each time the [△] key is pressed the displayed figure changes in ascending order: 0 → 1 → 2 → 0.
While the figure to be set is flashing, press the [ENT] key.
After accepting the specified value, the display proceeds to the setup stage of the next item.

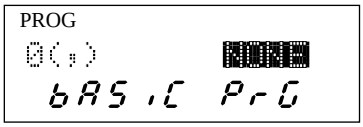


c. Putting a comma after the thousandths digit (Guidance: (,))

Set whether a comma (,) is inserted after the thousandths digit.

NONE : Not displayed → 12.34567
USE : Displayed → 12.345,67
(Default setting is NONE.)

Step 1: Each time the [∧] key is pressed the displayed string toggles between NONE and USE. Select the setting and press the [ENT] key. After accepting the specified digit position, the display proceeds to the setting the buzzer function.



d. Setting the buzzer function (Guidance: BUZZER)

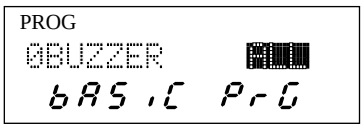
Set whether or not to enable (key input sensing sound and key entry error sound) and (±NG judgment sound). Note that the system error sounds (indicating that the printer or Digimatic Output Unit is not connected, or other system failures) are not disabled with this setting.

The types of buzzer sound are as follows:

1. Key input sensing sound: very short beep (0.05 sec)
2. Key entry error sound: short beep (0.2 sec)
3. ±NG judgment sound: long beep (1 sec)
4. System error sound: repeated short beeps at intervals of 0.2 seconds

ALL : Sounds a buzzer in all cases.
KEY : Enables the key input sensing sound + key entry error sound
NG : Sounds a buzzer when the judgment result is ±NG
NONE : Sounds a buzzer only if a system error occurs
(Default setting: ALL)

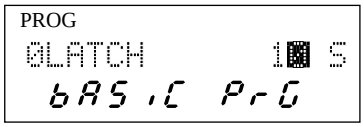
Step 1: Each time the [∧] key is pressed the displayed setup option changes in the following order: ALL → KEY → NG → NONE. If the desired option is flashing, press the [ENT] key. When the setup for the buzzer function is completed, operation automatically proceeds to the setting of the display latch timer.



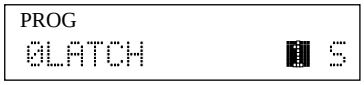
e. Setting the display latch timer (Guidance: LATCH)

Set the period the measurement result display is to be latched (held) on the display if a single-run measurement or continuous-run measurement is performed. Specify a value between 0 and 99 seconds. “0” seconds specifies an infinite (latch state not canceled). (Default setting: 10 seconds)

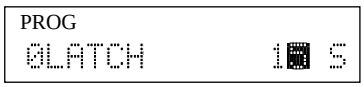
Step 1: This is an example of the display latch timer being set to 15 seconds.
Enter [1] and [5] in this order.



[1]

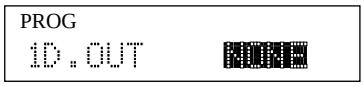


[5]



Step 2: Press the [ENT] key to save the setup data in memory.
The operation automatically proceeds to B1: Setting the output function in the ready state.

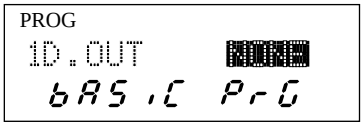
[ENT]



4.1.2.2 Selecting and setting the function in the B1 mode

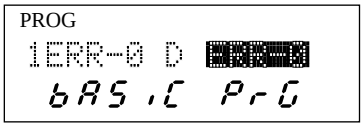
a. Setting the output function in the ready state (Guidance: D.OUT)
Set whether to perform GO/NG judgment result output in the ready state.
NONE : Neither kind of output is performed in the ready state.
OUT1 : Both kinds of output are performed, even in the ready state.
(Default setting: NONE)

Step 1: Each time the [∧] key is pressed the displayed setup option toggles between NONE and OUT1. While the desired setup option is flashing, press the [ENT] key. When the setup for this function has been completed, the operation automatically proceeds to the display setting in the event of Err-0.



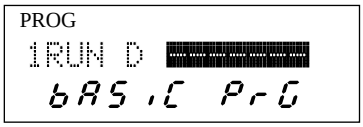
b. Selecting the display message if Err-0 occurs (Guidance: ERR-0 D)
ERR-0 : Displays "ERR-0".
0 : Displays "0" as the least significant digit.
(Default setting: ERR-0)

Step 1: Each time the [∧] key is pressed the displayed setup option toggles between ERR-0 and 0. While the desired setup option is flashing, press the [ENT] key. The operation automatically proceeds to the selection of the display message at the start of measurement.



c. Selecting the display message at the start of measurement (Guidance: RUN D)
Set the message to be displayed at the start of a single-run measurement or continuous-run measurement.
---------- : Displays "— — — — — — —".
PRE.D : Continuously displays the previous data.
(Default setting: ----------)

Step 1: Each time the [∧] key is pressed the displayed setup option toggles between ---------- and PRE.D. While the desired setup option is flashing, press the [ENT] key. The operation automatically proceeds to the selection of the averaging method.



d. Selecting the averaging method (Guidance: AVG.M)

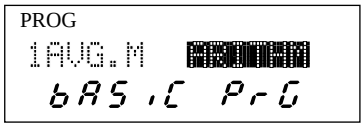
Select one of the following averaging methods: arithmetical average and moving average.

[redacted] : Arithmetical average

[redacted] : Moving average

(Default setting: [redacted])

Step 1: Each time the [∧] key is pressed the displayed setup option toggles between [redacted] and [redacted]. While the desired setup option is flashing, press the [ENT] key. The operation automatically proceeds to the selection of the GO/NG judgment method.



e. Setting the GO/NG judgment method (Guidance: JDG.M)

Select one of the following GO/NG judgment methods: (lower limit value and upper limit value), (multi-stage selection: 7 stages), and (target value + tolerance).

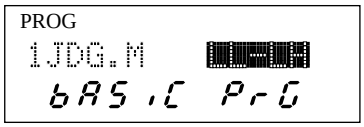
[redacted] : GO/NG judgment is performed according to the specified lower limit and upper limit.

[redacted] : GO/NG judgment is performed according to the multi-limit selection (7 stages).

[redacted] : GO/NG judgment is performed according to the specified target value and tolerance.

(Default setting: [redacted])

Step 1: Each time the [∧] key is pressed the displayed setup option changes in the following order: [redacted] → [redacted] → [redacted]. While the desired setup option is flashing, press the [ENT] key. If [redacted] is selected, operation proceeds to setting whether the target value is copied to the reference value. If [redacted] is not selected, operation proceeds to B2: Setting the workpiece type.



f. Setting whether the target value is copied to the reference value (Guidance: COPY)

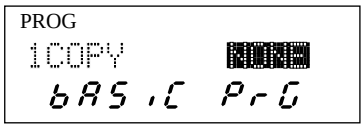
Set whether the target value is automatically copied to the reference value.

[redacted] : Target value is not copied to the reference value.

[redacted] : Target value is copied to the reference value.

(Default setting: [redacted])

Step 1: Each time [∧] key is pressed the displayed setup option toggles between [redacted] and [redacted]. While the desired setup option is flashing press [ENT] key. The operation automatically proceeds to setting B2: Setting the workpiece type.



4.1.2.3 Selecting and setting the function in the B2 mode

a. Setting the workpiece type (Guidance: WORK.P)

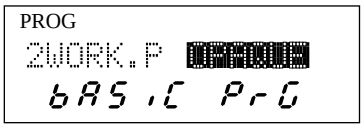
Set whether the workpiece is an opaque object or transparent object.

OPAQUE : Workpiece is an opaque object.

CLEAR : Workpiece is a transparent object.

(Default setting: OPAQUE)

Step 1: Each time the △ key is pressed the displayed setup option toggles between OPAQUE and CLEAR. While the desired setup option is flashing, press the ENT key. The operation automatically proceeds to setting whether to perform simultaneous measurement.



TIP If CLEAR is selected for the workpiece type, the guidance for the selection of the segment specification method is not displayed. It is omitted (the segment specification process is entered directly).

b. Setting the simultaneous measurement (Guidance: PROG)

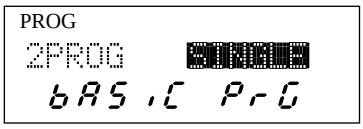
Set whether to perform simultaneous measurement.

SINGLE : Does not perform simultaneous measurement. (performs single measurement)

DUAL : Performs simultaneous measurement.

(Default setting: SINGLE)

Step 1: Each time the △ key is pressed the displayed setup option toggles between SINGLE and DUAL While the desired setup option is flashing, press the ENT key.



TIP If DUAL (simultaneous measurement) is selected
If simultaneous measurement is selected, the setup guidance for the following will not be displayed: Selecting the averaging method, segment specification, and setting the group judgment.

c. Selecting the method of specifying segments (Guidance: SEG)

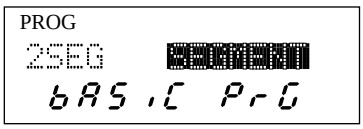
Select the method of specifying the measurement position from segment specification and edge specification.

SEGMENT : Uses segment specification.

EDGE : Uses edge specification.

(Default setting: SEGMENT)

Step 1: Each time the △ key is pressed the displayed setup option toggles between SEGMENT and EDGE. While the desired setup option is flashing, press the ENT key. The operation automatically enters B3: Setting the abnormal value elimination function.



NOTE If any of the following setting is performed, the system automatically proceeds to the stage of segment setup SEGMENT without displaying the guidance for the method of specifying segments SEG:

• a. CLEAR is selected in Setting the workpiece type.

4.1.2.4 Selecting and setting the function in the B3 mode

a. Setting the abnormal value elimination function (Guidance: ADE)

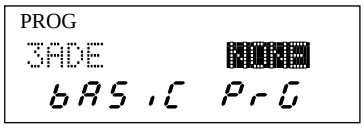
Set whether to use the abnormal value elimination function.

NONE : Does not use the abnormal value elimination function.

USE : Uses the abnormal value elimination function.

(Default setting: NONE)

Step 1: Each time the [∧] key is pressed the displayed setup option toggles between NONE and USE. While the desired setup option is flashing, press the [ENT] key. The operation automatically enters the process for setting the automatic workpiece detecting function.



b. Setting the automatic workpiece detecting function (Guidance: AWDT)

Set whether to use the automatic workpiece detecting function.

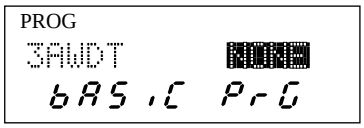
NONE : Does not use the automatic workpiece detecting function.

DIAM : Performs automatic workpiece detection with the diameter detection method.

POSITION : Performs automatic workpiece detection with the position detection method.

(Default setting: NONE)

Step 1: Each time the [∧] key is pressed the displayed setup option changes in the following order: NONE → DIAM → POSITION. While the desired setup option is flashing, press the [ENT] key. If NONE (the automatic workpiece detecting function is not used) is selected, the operation proceeds to setting the group judgment, otherwise it enters the process for setting the number of scans.



c. Setting the number of scans (Guidance: SCAN)

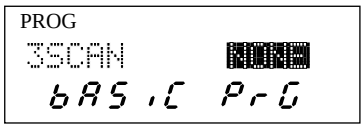
Set the number of scans that are used for the automatic workpiece detecting function.

16 : Detection from 16 scans

1 : Detection from a single scan

(Default setting: 16)

Step 1: Each time the [∧] key is pressed the displayed setup option toggles between 16 and 1. While the desired setup option is flashing, press the [ENT] key. The operation automatically enters the process for setting the group judgment.



NOTE Even if 16 scans are specified in the position detection method, the actual detecting operation will be performed with a single scan.

d. Setting the group judgment (Guidance: GTJ)

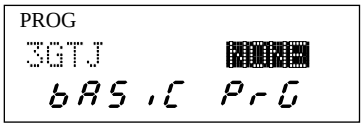
Set whether to use the group judgment function.

NONE : Does not use the group judgment function.

USE : Uses the group judgment function.

(Default setting: NONE)

Step 1: Each time the △ key is pressed the displayed setup option toggles between NONE and USE. While the desired setup option is flashing, press the ENT key. If NONE is selected, the operation proceeds to B4: Setting the use of RS-232C baud rate, and if USE is selected, the operation enters the process for setting the group judgment result output function.



e. Setting the group judgement output (Guidance: GTJ D)

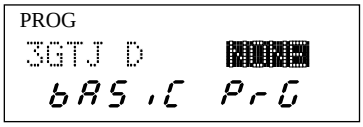
Set whether to output the group judgment result to the RS-232C interface.

NONE : Does not output the group judgment result to the RS-232C interface.

OUT : Outputs the group judgment result to the RS-232C interface.

(Default setting: NONE)

Step 1: Each time the △ key is pressed the displayed setup option toggles between NONE and OUT. While the desired setup option is flashing, press the ENT key. The operation automatically proceeds to B4: Setting the use of RS-232C port.



4.1.2.5 Selecting and setting the function in the B4 mode

a. Setting the use of RS-232C port (Guidance: RS-232C)

Set if the RS-232C port is used as the communication port (COM) for a personal computer, etc., or as the printer port, or is not used for either.

COM : Used as the communication port (COM) for a personal computer, etc.
PRN : Used as the printer port
NONE : Is not used for either purpose
(Default setting: COM)

Step 1: Each time the [∧] key is pressed the displayed setup option changes in the following order: COM → PRN → NONE. While the desired setup option is flashing, press the [ENT] key. If NONE is selected, the operation proceeds to B5: Reserved, otherwise it enters the process for setting the RS-232C communication speed.

PROG
4RS-232C COM
bASiC PrG

b. Setting the RS-232C communication baud rate (Guidance: BAUD)

Set the RS-232C communication speed (baud rate).

9600 : Uses 9600 bps.
19200 : Uses 19200 bps.
1200 : Uses 1200 bps.
2400 : Uses 2400 bps.
4800 : Uses 4800 bps.
(Default setting: 9600)

Step 1: Each time the [∧] key is pressed the displayed setup option changes in the following order: 9600 → 19200 → 1200 → 2400 → 4800. While the desired setup option is flashing, press the [ENT] key. The operation automatically enters the process for setting the RS-232C data bits.

PROG
4BAUD 9600
bASiC PrG

c. Setting the RS-232C communication data bits (Guidance: LENGTH)

Set the data bits for RS-232C communication.

8 : Uses 8 bits.
7 : Uses 7 bits.
(Default setting: 8)

Step 1: Each time the [∧] key is pressed the displayed setup option toggles between 8 and 7. While the desired setup option is flashing, press the [ENT] key. The operation automatically enters the process for setting the parity check method for RS-232C communication.

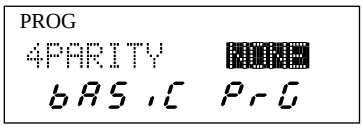
PROG
4LENGTH 8
bASiC PrG

d. Setting the RS-232C communication parity bit (Guidance: PARITY)

Set the parity check method for RS-232C communication.

NONE : Does not use parity check.
ODD : Uses odd parity.
EVEN : Uses even parity.
(Default setting: NONE)

Step 1: Each time the [∧] key is pressed the displayed setup option changes in the following order: NONE → ODD → EVEN. While the desired setup option is flashing, press the [ENT] key. The operation automatically enters the process for setting the delimiter for RS-232C communication .

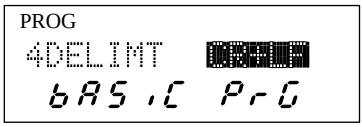


e. Setting the delimiter for communication (Guidance: DELIMT)

Set the delimiter (termination code of one sentence) for RS-232C communication.

CR+LF : Uses CR+LF as the delimiter.
CR : Uses CR code as the delimiter.
LF : Uses LF code as the delimiter.
(Default setting: CR+LF)

Step 1: Each time the [∧] key is pressed the displayed setup option changes in the following order: CR+LF → CR → LF. While the desired setup option is flashing, press the [ENT] key. The operation automatically enters the process for setting the control method of the RS-232C communication flow.



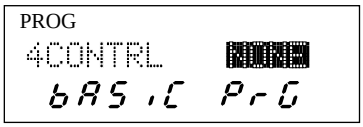
f. Setting the RS-232C line control (Guidance: CONTRL)

Set the method of controlling the RS-232C communication flow.

NONE : Does not use a particular control signal (using 3-wire teletype control).
USE : Uses a control signal.
(Default setting: NONE)

Note: If the RS-232C interface is set as the printer port, line control will be achieved by BUSY signals even if this option was set to NONE.

Step 1: Each time the [∧] key is pressed the displayed setup option toggles between NONE and USE. While the desired setup option is flashing, press the [ENT] key. The operation automatically proceeds to B5: Reserved.



4.1.2.6 B5: Reserved

B5 is not neccessarily to be set, press the [ENT] key.

B6: The operation automatically proceeds B6: Setting the use of DCU.

4.1.2.7 Selecting and setting the function in the B6 mode

a. Setting the use of DCU (Guidance: DCU)

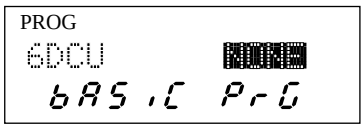
Set whether to use the Mitutoyo Data Processing Unit interface called DCU (Digimatic Output Unit).

NONE : Does not use DCU.

USE : Uses DCU.

(Default setting: NONE)

Step 1: Each time the [△] key is pressed the displayed setup option changes in the following order: NONE → USE. While the desired setup option is flashing, press the [ENT] key. The operation automatically returns to B0: Setting the resolution.

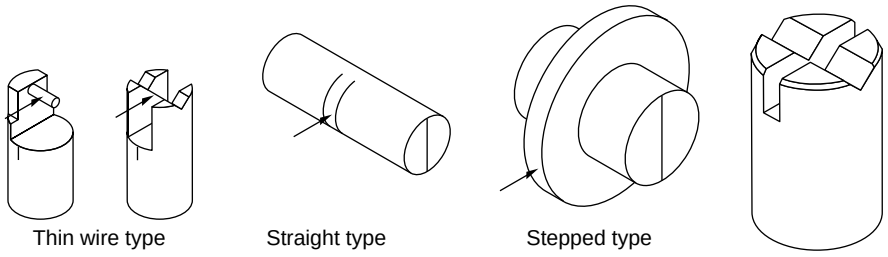


4.2 Calibration

The LSM system can be calibrated quite easily and with high accuracy.

4.2.1 Calibration gages and gage stand

Supported calibration gages and gage stand have the following shapes.



Calibration gages and stand

Gage stand

4.2.2 Entering the calibration mode

Enter the calibration mode with the following procedure.

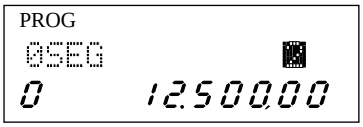
< Preparation >

(1) Turn on the power and wait at least one hour for the system to thermally stabilize.

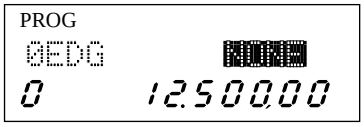
(2) Prior to use, wipe dust and oil from the gage and gage stand with a cloth soaked in alcohol or thinner. If calibration has been completed, carefully store them in a dedicated case after applying a rust preventive oil to their surfaces.

(3) Specify SEG 2.

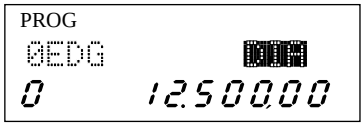
For information about the method of segment specification, refer to Section 4.5, “Setting Up the Functions”.



On edge specification, select either manual measurement or automatic measurement with respect to diameter.

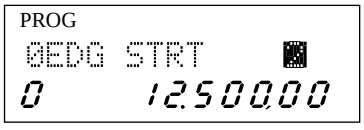


a) Manual measurement

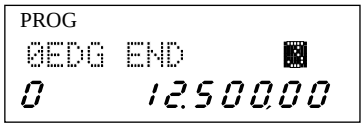


b) Automatic measurement

Set the start edge to 2 and the end edge to 3.

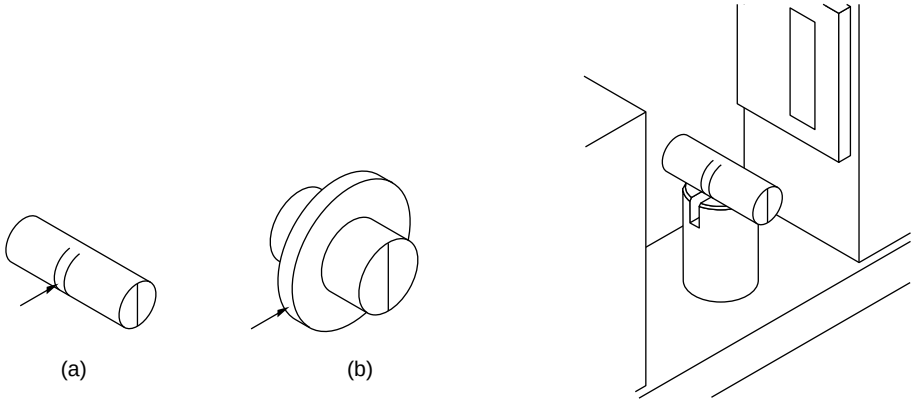


a) Start edge



b) End edge

(4) Setting the HIGH CAL gauge.
HIGH CAL gages vary in shape depending on the LSM model to be calibrated. Set the calibration gage so that the calibration guide line (|) on the side face of the calibration gage comes vertical, and so that the center of the calibrated section is measured.
In diagram (a), the calibrated position is at the center of the (| |) mark, and the center of the width (indicated by the arrow mark) in diagram (b).



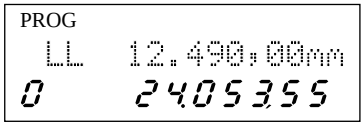
Step 1: Cancel the previously set calibration values.
It is not necessary if this setup operation is made with the previously used calibration gage. However, if the new gage diameter is much different from that of the previous one, an error (Err-2) may result. If this is the case, cancel the LOW CAL calibration value, then begin with the setting of HIGH CAL value (it does not matter if both the LOW CAL and HIGH CAL values are canceled).

1) Cancel the previous LOW CAL data. Press the [L.CAL] key in the ready state to initiate the LOW CAL setup mode.

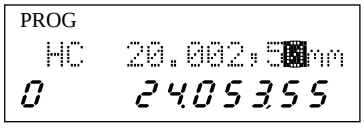
2) Press the [C] and [ENT] keys to cancel the LOW CAL data. This automatically restores the ready state.

[C]

[ENT]

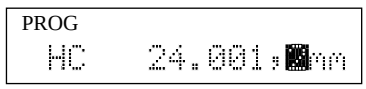


Step 2: Mount the HIGH CAL gage on the stand.
Press the [H.CAL] key in the ready state. The previously set HIGH CAL value is displayed, and the HIGH CAL setup mode is entered.



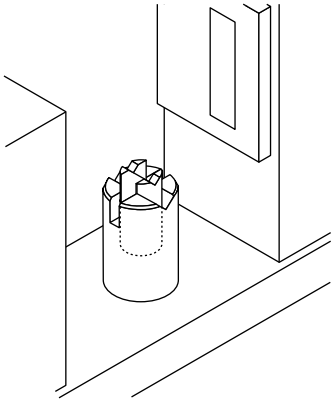
Step 3: Enter the approved dimension of the HIGH CAL gage.
Example.)

[2] [4] [.] [0] [0] [1] [2]

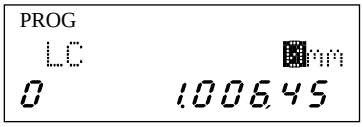


Step 4: If the [ENT] key is pressed to save the HIGH CAL setup value in memory, the operation automatically returns to the ready state.

Step 5: Set the LOW CAL gage.
As with the HIGH CAL gage, the LOW CAL gages vary in shape depending on the LSM model to be calibrated. Set the LOW CAL gage so that the center of the calibration range is properly measured.
A LOW CAL gage for calibrating dimensions less than 2 mm should be set so that it fits with the mounting hole of the gage stand.

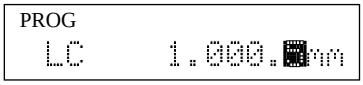


Step 6: Set up the LOW CAL gage.
In the ready state press the [L.CAL] key. The previously set LOW CAL value is displayed, and the LOW CAL setup mode is entered.

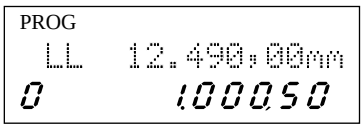


Step 7: Enter the verified dimension of the LOW CAL gage.

[1] [.] [0] [0] [0] [5]



Step 8: If the [ENT] key is pressed to save the LOW CAL setup value in memory, the operation automatically returns to the ready state.

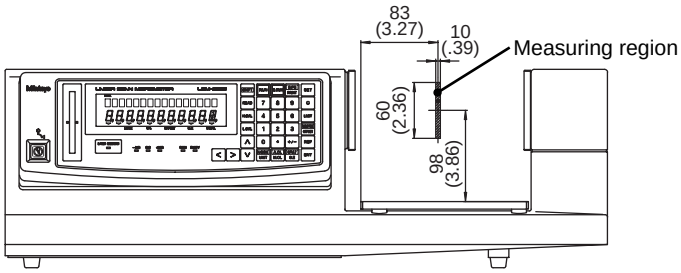


IMPORTANT Calibration

1. Before performing a calibration, always perform the necessary setup for the resolution, etc. If this order is reversed, the set calibration value may be canceled and the measurement accuracy is not guaranteed.
2. Canceling the HIGH CAL value will also cancel the LOW CAL, offset, and mastering values.
3. With only a LOW CAL setup value the compensation calculation does not take place. This calculation will start when a HIGH CAL (or HIGH CAL and LOW CAL) value is set.
   If a HIGH CAL value is set, the CAL guidance (▼) will turn on in the display unit.
4. A calibration gage is important in that it is critical to the accuracy of the Measuring Unit. Wipe dust and oil from the gage with a cloth soaked in alcohol or thinner before using it.
   After use, apply a rust preventive oil to its surfaces and store it carefully in a dedicated case.
5. To confirm the HIGH CAL or LOW CAL setup value, press either the H.CAL or L.CAL key to enter each setup mode, and press the H.CAL (and SET) or L.CAL (and SET) key to exit to the ready state after the confirmation is over. Do not perform the setup operation in the confirmation process of the setup data.
6. On the user-supplied calibration gages, the dimensional ratio of a High CAL gage to a Low CAL gage should be greater than 1.2. Calibration performed with the calibration gages with diameters that are too close each other may reduce the measuring accuracy. The calibration gage should be the one which is made of the same or similar material as that of the workpiece. If a calibration gage of different material is used, error may be involved in measurement due to the difference in surface textures or properties.
7. For calibration measurement, no restriction exist for segment specification. If a gap or displacement needs to be precisely measured, a thickness gage can be used for calibration. (There will be a slight difference in measured data between those from OD and gap depending on the segment specified for calibration.)

4.3 Positioning a Gage or a Workpiece

1. Position the calibration gage or workpiece so that it is located at the middle of the measurement position.
   The shaded section in the following diagram is the measuring region where the rated measuring accuracy of this system is obtained.
2. It is also possible to measure a workpiece or gage located outside the measuring region, as long as it is within the laser beam scanning range, however, the measurement accuracy will be reduced.

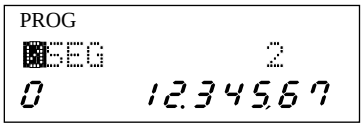


4.4 How to read-in the amount of light

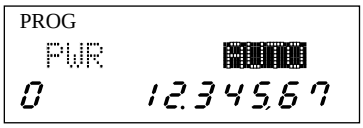
For measurement of the fine gap where the light passing through it can not be sufficiently secured it is necessary for the system to read-in the amount of light. For more information refer to Section 3.2.15, “Recording the amount of light”.

Step 1: Removal of obstructions
Remove any objects (workpiece and fixture) that obstruct the laser path before reading in the amount of light.

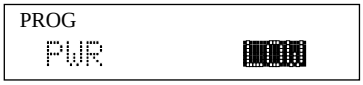
Step 2: Enter the function setup mode from the ready state.



Step 3: Press the SHIFT and READ keys while the function setup number is flashing to enter the light amount check mode.
Each time the ∧ key is pressed the setup option toggles between AUTO (automatic detection) and READ (reading in the amount of light).



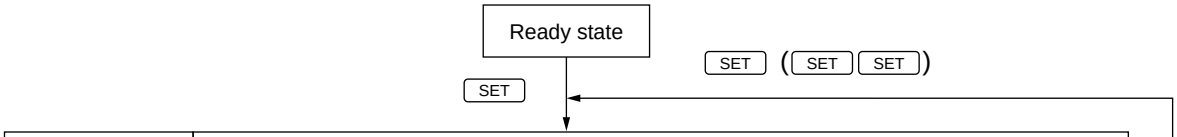
Step 4: Press the ENT key while READ is flashing.
If a sufficient amount of light is detected as a result of this positive check, the operation automatically returns to the ready state. If LOW is displayed, it indicates that the amount of light is insufficient. If this is the case, remove any obstruction and cancel the error with the C key, then perform step 4 again.



4.5 Setting Up the Functions

Make measurement-related setups based on the conditions set in Section 4.1, “Basic Setup”.

4.5.1 Outline of the function setup mode



Function No.	Setup contents
F0	Setting the segment In the basic setup mode, first set whether the workpiece is an opaque or transparent object. If it is an opaque object, then it is possible to specify the number of segments and edges to be measured. With the edge specification a multiple-pin workpiece can be measured automatically. ◎ Segment specification: SEG (Opaque object: 1 to 7, Transparent object: 1 to 3) • Edge specification: EDG (Manual: NONE / Automatic: PIT / Automatic: DIA / Automatic: GAP) • Start edge : STRT (Between edge number 1 and 254) • Finish edge : END (Between edge number 2 and 255)
F1	Setting the measurement interval (measurement time) Note1 In the basic setup mode either of the two setting methods can be selected. ◎Arithmetical average: MR ARM (1 to 2048) • Moving average: MR MOV (32 to 2048)
F2	Setting the GO/NG judgment criteria In the basic setup mode either of the three setting methods can be selected. In addition, if the abnormal value elimination function will be specified, the limits (Lower abnormal limit: EL → Upper abnormal limit: EH) for this abnormal value elimination should be set prior to other setup items. ◎Lower limit : LL → Upper limit: LH • Multi-limit selection 1: L1 → Multi-limit selection 2: L2 → Multi-limit selection 3: L3 • • • • → Multi-limit selection 6: L6 Target value : NO → Lower tolerance limit: LO → Upper tolerance limit: UP
F3 Note2	Setting the reference value In the basic setup mode it is possible to copy the setup data of a target value to the reference value. If this is done the setup guidance for the reference value is not displayed. ◎Reference value: REF
F4	Setting the offset and mastering Both the offset and mastering can be set. ◎Offset: OFS → Direction: DIR (0 , 1) → Mastering: MST
F5	Setting the data output condition Data output condition: DAT O.C (0 to 9) : If 1, 3 or 5 is selected → Periodic data output: DAT TIM (0 to 999)
F6	Sample measurement Note1 Number of samples: SMP N (0 ~ 999) → Calculation item: SMP ITM (Mean: AVG / Maximum value: MAX / Minimum value: MIN / Range: RNG)

Function No.	Setup contents
F7 Note2	Setting automatic workpiece detection In the basic setup mode either detection by dimension or detection by position can be selected. If "Not performing the automatic workpiece detection" is selected, the setup guidance for the following option will not be displayed. Number of measurements: AUT N (0 to 999) → Invalidation period: AUT TIM (0 to 9999) → Detection lower limit: AUL → Detection upper limit: AUH
F8 Note2	Setting the group judgment In the basic setup mode setups for the group judgment can be made. If "Not performing the group judgment" is selected, the setup guidance for the following option will not be displayed. • Group size : GTJ N (0 ~ 99) → Statistical item: GTJ ITM (Average: GAG / Maximum value: GMX / Minimum value: GMN / Range: GRG) • Group lower limit value: GLL → Group upper limit value: GLH

◎Settings following the circle are factory settings.

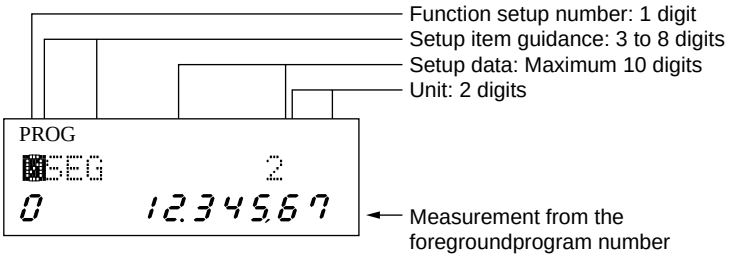
• Settings following a dot are ones which have been selected in the basic setup.
Settings with no marking can be made in only one way.

NOTE 1: Measurement interval and the number of samples are automatically matched in simultaneous measurement.

NOTE 2: The function number may not be displayed depending on the basic setup contents.

4.5.2 Outline of each function setup mode

1. Data display unit
   If the basic setup mode is entered, the following is displayed.
   The function setup number ▮ will be flashing in the most significant digit of the upper display section, and the guidance for the setup item, followed by the setup value, will be shown to the right of the setup number.
   In the lower display section the measurement from the foreground program number will be displayed.



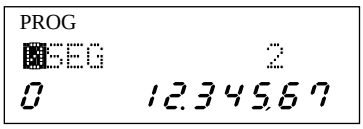
2. Setting each setup item
   - Use the numeric keys for setting the setup value, such as an offset value, and use the [∧] and [∨] keys for selecting the item, such as the statistical item of the sample measurement.
   - Press the [ENT] key to accept and save the setup data. After the setup content has been accepted, the operation automatically proceeds to the next setup item.

3. Setup values that must meet the large/small relationships
   The setup values for GO/NG judgment should meet the following relationships: Abnormal lower limit < Abnormal upper limit, Lower tolerance limit < Upper tolerance limit, and Lower limit value < Upper limit value.
   If the previously specified setup value needs to be modified to a great extent, it is recommended to first enter the new setup value thats meets the existing large/small relationship or, for safety, cancel the both sides to 0 then set them again.

4. Confirming the setup contents of each setup item
   To confirm the setup contents of each setup item use only the [ENT] key, which does not affect the setup contents.

5. Terminating the function setup mode
   - If the [SET] key is pressed while the function setup number is flashing, operation returns to the ready state.
   - If the [SET] key is pressed in the setup mode of each setup item, operation returns to the selection of a function setup number. If the [SET] key is pressed again at this point, operation returns to the ready state.
   - If the power is turned off halfway to the setup operation, on-going setup contents will not be saved in memory. The contents must be set again.

4.5.3 Function setup mode



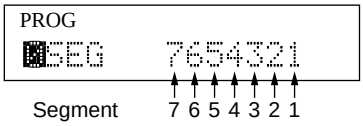
- If the function setup mode is entered using the [SET] key in the ready state, the function setup number will be flashing as shown in the figure at the right.
- Each time the [∧] key is pressed when the function setup number is flashing, it will change as follows: → → → → → → → → → → . Press the [ENT] ([<]) key while the desired function setup number is flashing to enter the setup mode. If the [∨] key is pressed, this order will be reversed.
- If a key other than the [∧], [∨], [<], [ENT] and [SET] keys are pressed during the selection of a function setup number, an operation error will result.
- If each piece of setup data is accepted with the [ENT] key in the corresponding setup mode, the operation will automatically proceed to the next setup item.

4.5.3.1 F0: Setting the segment

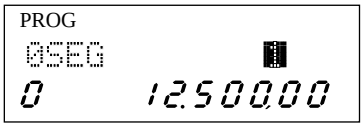
Use this function to set the measurement position (segment). The segment specification and edge specification methods are provided for this purpose. Both can be selected in the basic setup.

If this setup mode is entered, the previously established data will flash.

1) Segment specification
Places for displaying the segment numbers are fixed as shown in the figure at the right. In this example, set to SEG2.

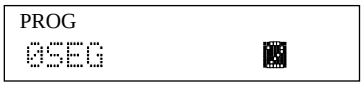


Step 1: If the segment setup mode is entered, the previously established data will be displayed.



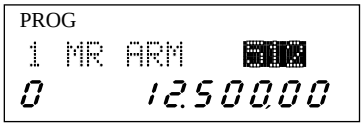
Press the [2] key.

[2]



Step 2: Press the [ENT] key to save the setup data in memory.
Operation automatically proceeds to the measurement interval setting.

[ENT]



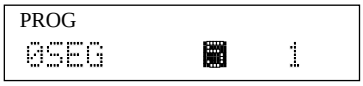
TIP Segment setup example

1. Set to segments (2 + 4).

[2] [4]

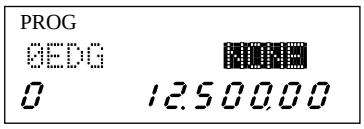
2. Set to segments (1 + 5).

[1] [5]



2) Edge specification

Step 1: If the edge specification mode is entered, the previously established manual measurement/ automatic measurement item will be displayed.



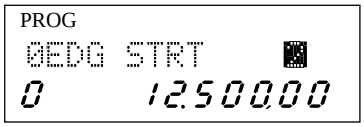
Each time the [∧] key is pressed the setup option changes in the following order: Manual measurement: NONE → Automatic measurement for pitch: PITCH → Automatic measurement for diameter: DIAM → Automatic measurement for gap: GAP. If the desired setup option is displayed, press the [ENT] key.

[∧]

Operation automatically enters the process of setting the start edge.

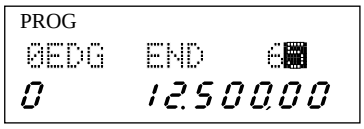
Step 2: Set the start edge (between number 1 and 254)
In this example, set the start edge to number 2.
If the [ENT] key is pressed, the operation automatically enters the process for setting the finish edge.

[2]



Step 3: Set the end edge (between number 2 and 255)
In this example, set the end edge to number 65.
If the [ENT] key is pressed, the operation automatically proceeds to F1: Setting the measurement interval.

[6] [5]



TIP

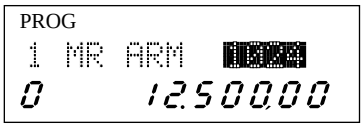
1. If a calibration is performed using the reference gage (placed in SEG2) with the edge specification active, select Manual measurement: NONE or Automatic measurement for diameter: DIAM, then set the start edge to 2 and end edge to 3.
2. If the checks on the start and end edges, performed at the end of the setup operation, result in start edge > end edge, exchange the start and end edge data. If the check result shows that both edge numbers are identical, an error (Err-5) results. If this occurs, cancel the setup data and begin the setting with the start edge.

4.5.3.2 F1: Setting the measurement interval (measurement time)

Use this function to set the measurement interval. This measurement interval should be set according to the arithmetical average and moving average, whichever is specified in the basic setup.

1) Arithmetical average (Guidance: MR ARM)

Step 1: The previously set number of scans for averaging is displayed. Select between 1 and 2048 times . The relationship between the number of scans for averaging and measurement intervals are shown in the table below.



Relationship between the number of scans for averaging and measurement intervals (measurement times)

Number of scans for averaging	Measurement intervals (measurement time)		
	Arithmetical average	Moving average	
		1st measurement	2nd and subsequent measurements
1	0.00063 sec		–
2	0.0013 sec		–
4	0.0025 sec		–
8	0.005 sec		–
16	0.01 sec		–
32	0.02 sec	0.02 sec	0.01 sec
64	0.04 sec	0.04 sec	0.01 sec
128	0.08 sec	0.08 sec	0.01 sec
256	0.16 sec	0.16 sec	0.01 sec
512	0.32 sec	0.32 sec	0.01 sec
1024	0.64 sec	0.64 sec	0.01 sec
2048	1.28 sec	1.28 sec	0.01 sec

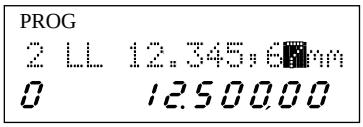
Each time the [∧] key is pressed, the setup option changes in the following order: [illegible] → [illegible] → [illegible] → [illegible] → [illegible] → [illegible] → [illegible] → [illegible] → [illegible] → [illegible] → [illegible] → [illegible] → [illegible]. For this example select 512 times.

Select 512 times.

[∨]

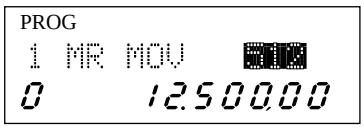
Step 2: Press the [ENT] key to save the setup data in memory.
The operation automatically proceeds to F2: Setting the GO/NG judgment criteria.

[ENT]



2) Moving average (Guidance: MR MOV)

Different in the setup guidance (MOV) and the number of scans for averaging (between 32 and 2048), however, the setup method is same with the arithmetical average.



NOTE
1. A larger number of scans for averaging will improve the repeatability. If measuring time permits, set the greatest number of scans for averaging possible.
2. If the number of scans for averaging is set to between 1 and 4, the scan signals will be thinned for the measurement. This results in a measurement interval of 0.002 to 0.003 second.

4.5.3.3 F2: Setting the GO/NG judgment criteria

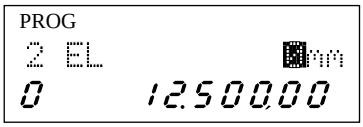
Set the GO/NG judgment criteria according to the tolerance judgment method: (Lower limit value + Upper limit value), (Multi-stage selection: 7 stages), and (Target value + tolerance), whichever is specified in the basic setup. If "Using the abnormal value elimination function" has been specified, the abnormal limit values should be set prior to setting the GO/NG judgment criteria.

In this example assume that the machining target value is 12.5 $^{+/- 0.01}$ mm, and that all the abnormal limits (lower and upper) and GO/NG judgment criteria are canceled (set to 0).

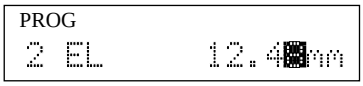
1) Setting the abnormal limit values

Set as follows: Lower abnormal limit = 12.48 mm, Upper abnormal limit = 12.52 mm.

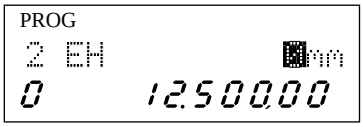
Step 1: The previously set lower abnormal limit is displayed.
Enter "12.48".



1 2 . 4 8

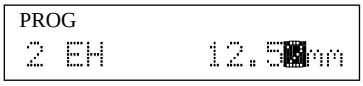


Step 2: Press the ENT key.
The setup data will be saved in memory and operation automatically proceeds to the setting for the upper abnormal limit.

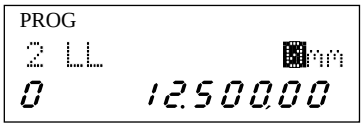


Step 3: Enter "12.52", which is the setup data for the upper abnormal limit.

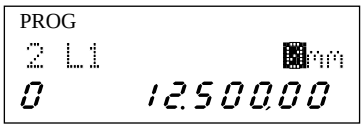
1 2 . 5 2



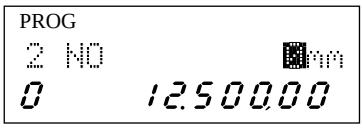
Step 4: Press the ENT key.
The setup data will be saved in memory and operation will automatically proceed to the GO/NG judgment criteria setting.
The method of GO/NG judgment varies with the contents of the basic setup.



Case of
(Lower limit value and Upper limit value)



Case of (Multi-stage selection)

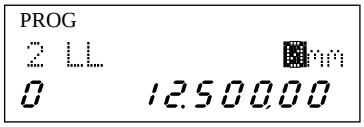


Case of (Target value + tolerance)

2) GO/NG judgment criteria setting (by "Lower limit value and upper limit value")

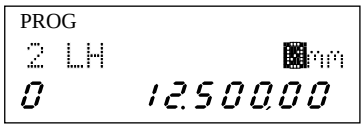
In this example assume that the lower limit value is 12.49 mm and that the upper limit value is 12.51 mm.

Step 1: The previously set lower limit value is displayed. Enter "12.49".



[1] [2] [.] [4] [9]

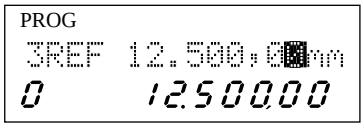
Step 2: Press the [ENT] key.
The setup data will be saved in memory and the operation automatically proceeds to the upper limit value setting.



Step 3: Enter "12.51", which is the setup data for the upper limit value.

[1] [2] [.] [5] [1]

Step 4: Press the [ENT] key.
The setup data will be saved in memory and the operation automatically proceeds to the reference value setting.

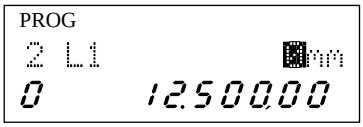


3) Setting the GO/NG judgment criteria (by multi-limit selection)

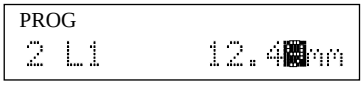
In this example assume the following:

L1=12.49mm
L2=12.494mm
L3=12.498mm
L4=12.502mm
L5=12.506mm
L6=12.51mm

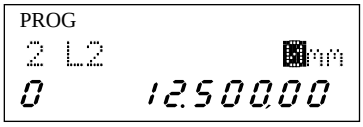
Step 1: The previously entered setup value for L1 is displayed.
Enter “12.49”.



1 2 . 4 9

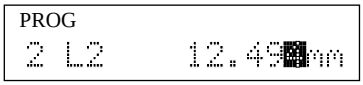


Step 2: Press the ENT key.
The setup data will be saved in memory and the operation automatically proceeds to the L2 setting.

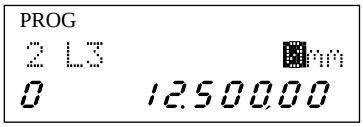


Step 3: Enter “12.494”, which is the setup data for L2.

1 2 . 4 9 4

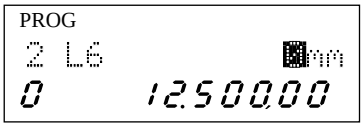


Step 4: Press the ENT key.
The setup data will be saved in memory and the operation automatically proceeds to the L3 setting.

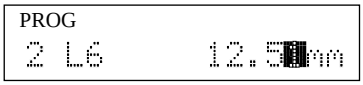


Step 5: As with L1 and L2, set L3, L4, and L5.

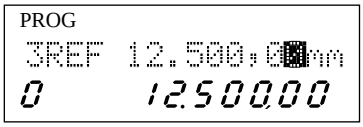
Step 6: Enter “12.51”, which is the L6 setup value.



1 2 . 5 1



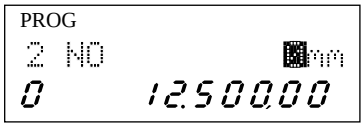
Step 7: Press the ENT key.
The setup data will be saved in memory and the operation automatically proceeds to the reference value setting.



4) Setting the GO/NG judgment criteria (with "Target value + tolerance")

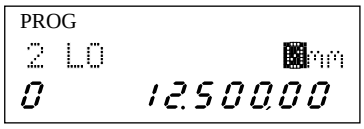
In this example assume that the target value is 12.5 mm, lower tolerance is -0.01 mm, and upper tolerance is 0.01 mm.

Step 1: The previously set target value is displayed.
Enter "12.5".



[1] [2] [.] [5]

Step 2: Press the [ENT] key.
The setup data will be saved in memory and the operation automatically proceeds to the lower tolerance value setting.
The target value will be automatically copied on the reference value if so set in the basic setup.

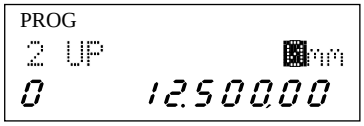


Step 3: Enter "0.01", which is the lower tolerance value, and a negative sign.

([0]) [.] [0] [1]

[+/-]

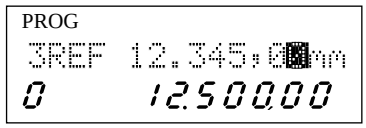
Step 4: Press the [ENT] key.
The setup data will be saved in memory and the operation automatically proceeds to the upper tolerance value setting.



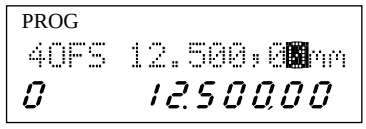
Step 5: Enter "0.01", which is the upper tolerance value.

([0]) [.] [0] [1]

Step 6: Press the [ENT] key.
The setup data will be saved in memory and the operation automatically proceeds to the reference value setting.
The displayed guidance for the setup item will vary depending whether "Copying the target value to the reference value" has been specified in the basic setup.



When not copying the target value to the reference value.



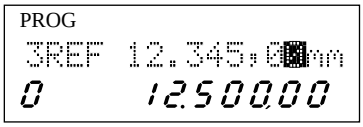
When copying the target value to the reference value.

4.5.3.4 F3: Setting the reference value

Set the reference value here. If “Copying the target value to the reference value” has been specified in the basic setup, the setup guidance for the reference value will not be displayed.

In this example assume that the reference value is 12.5 mm.

Step 1: The previously set reference value is displayed. Enter “12.5”.

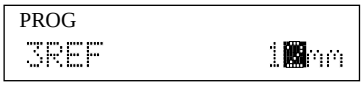


If “1” is entered the currently displayed setup value changes to “1”, however, it will not be saved in memory until the [ENT] key is pressed.

[1]

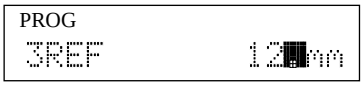
Enter “2”.

[2]



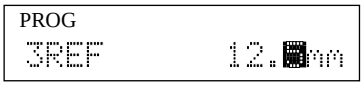
Enter a decimal point (“.”).

[.]

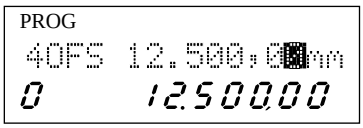


Enter “5”.

[5]



Step 2: Press the [ENT] key.
The setup data will be saved in memory and the operation automatically proceeds to the offset value setting.

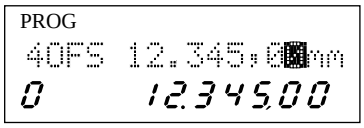


4.5.3.5 F4: Setting the offset value

Set the offset value and/or mastering value here.

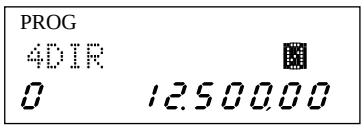
In this example assume that the offset value is 12.5 mm, the direction is 0 (positive), and the mastering value is 0.0. Assume also that the current offset value is 12.345 mm.

Step 1: The previously set offset value is displayed.
Enter “12.5”.

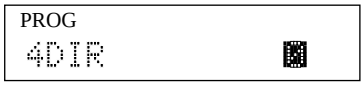


[1] [2] [.] [5]

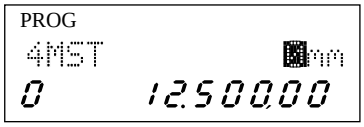
Step 2: Offset guidance (▼) turns on and the setup data will be saved in memory and the operation automatically proceeds to the direction setting.



Step 3: Set the direction to “0”.
Since in this example the previous setting is “0”, it is not necessary to enter the same value again. However, if there is a need to change the direction to “1”, enter “1”.



Step 4: Press the [ENT] key.
The setup data will be saved in memory and the operation automatically proceeds to the mastering value setting.



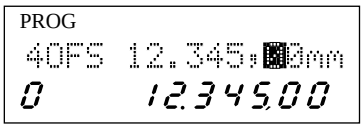
Step 5: Enter “0.0”, which is the mastering value.

[0] [.] [0]

Step 6: Press the [ENT] key.
The setup data will be saved in memory and the operation automatically enters the data output condition setting.

IMPORTANT How to use the offset function

1. To obtain an offset value, it is necessary to set up the reference gage in place (the offset value is a compensation value determined from the measurement of the reference gage). This offset setup takes about 1 second.
2. If the existing setup value is applied, it is not necessary to carry out the offset. To force the offset operation using the same data, move the highlighted digit place with the [<] key. This makes the offset carried out, since the system judges the data is changed.
   For this operation press the [MASTER]/[OFFSET] key in the ready state. With this single key operation offset will be carried out.



3. So that the maximum displayable range is not exceeded during measurement, the offset value must be set well within the maximum value shown in the table below. If measured data exceed the maximum value, “9999999” will be displayed.

Resolution (μm)	Maximum value (mm)
0.05	±89.99999
0.1/0.2/0.5	±899.9999
1/2/10/100	±8999.999

Resolution (E)	Maximum value (E)
.000002/ .000005	±8.999999
.00001/.00002/.00005/ .0001/.0005/.005	±89.99999

4. Precautions prior to modifying the unit system
   Note that if an offset value exceeds the above described maximum value when the unit system is changed from E to metric, the offset function will automatically be reset.
   (Example: If the integer part of the maximum value is restricted to 2 digits, converting from 4E to 101.6 mm will exceed the limit.)

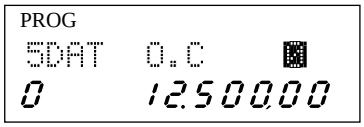
4.5.3.6 F5: Setting the data output conditions

Set the data output conditions (0 to 9) and periodical output timer (0 to 999 sec.).

The unit used with the periodical output timer is seconds. Setting it to “0” means that output takes place for each measurement.

In this example assume that the data output condition is 3 and that the periodical output timer is 10 seconds.

Step 1: The previously set data output conditions are displayed.
The setup data for the data output conditions is shown in the table below.

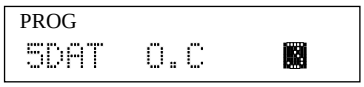


Data output condition	RS-232C DCU	Printer	Remark
0	—	—	
1	—	○	The periodical output timer can be set
2	—	△	
3	○	—	The periodical output timer can be set
4	△	—	
5	○	○	The periodical output timer can be set
6	△	△	
7	—	□	
8	□	—	
9	□	□	

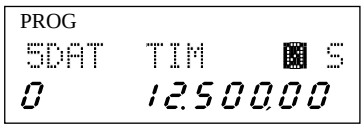
○ : Outputted for each measurement if RUN or CRUN key, etc., is pressed.
△ : Press the RUN or CRUN key to trigger the measurement. The measurement result will be outputted if it falls on GO.
□ : Press the RUN or CRUN key to trigger the measurement. The result will be outputted if it falls on ±NG.
— : No output will be made.

Enter “3” as the data output condition.

3

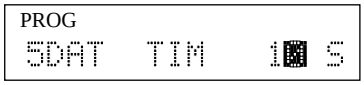


Step 2: Press the ENT key.
If the data output condition is 1, 3, or 5, the operation proceeds to the periodical output timer setting, otherwise it proceeds to the sample measurement setting.

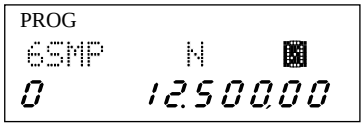


Step 3: Set the periodical output timer to 10 seconds.

1 0



Step 4: Press the ENT key to save the setup data in memory.
The operation enters the sample measurement setting.



4.5.3.7 F6: Setting the sample measurement

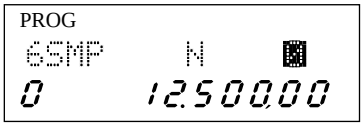
Set the conditions for the sample measurement here.

For this sample measurement use single-run measurement or continuous-run measurement, and select either 0, 1 , or 2 to 999 samples.

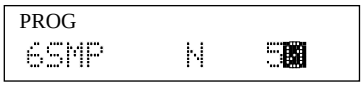
Number of samples	Single-run measurement	Continuous-run measurement
0	Called "zero-run measurement". Measurement is initiated by pressing the key assigned to single-run measurement, and measurement continues until the same key is pressed again. The result of the specified statistical item will be displayed as it is latched on the display.	Does not function (causes an input error).
1	The sample measurement does not take place, but a normal single-run measurement does.	The sample measurement does not take place, but a normal continuous-run measurement does.
2~999	The specified number of samples are measured and the result of the specified statistical item will be displayed as it is latched on the display.	The single-run measurement described at the left will be repeated.

In this example assume that the number of samples is 50, and the statistical item is range.

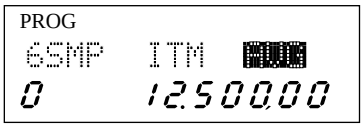
Step 1: The previously set number of samples flashes.



Enter “50” as the number of samples. [5] [0]



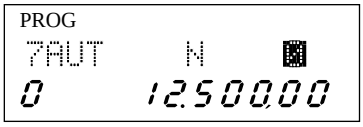
Step 2: Press the [ENT] key.
If the number of samples entered is “1”, the operation proceeds to the automatic workpiece detection setting, otherwise if “0” or “2 to 999” is entered, it proceeds to the statistical item setting.



Step 3: Select the objective statistical item. Each time the [∧] key is pressed, the setup option changes in the following order: [redacted] → [redacted] → [redacted] → [redacted]. Select [redacted] in this example.

([∧] [∧] [∧]) [∨]

Step 4: Press the [ENT] key.
The operation automatically proceeds to the automatic workpiece detection setting.



4.5.3.8 F7: Automatic workpiece detection setting

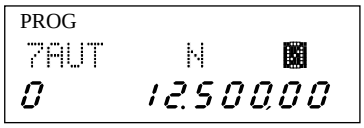
Set the conditions for automatic workpiece detection here.

Select between 0 (no automatic workpiece detection) and 999 measurements, and select between 0 to 9999 ms for the invalidation period.

In this example assume the following:

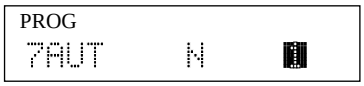
Number of measuring times =1, Invalidation period = 100 ms (0.1 sec), Lower detection limit = 12.2 mm, Upper detection limit = 12.8 mm.

Step 1: The previously set data output condition is flashing.

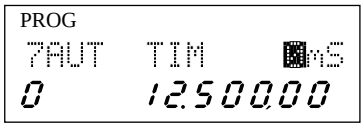


Enter “1” as the number of measurements.

[1]

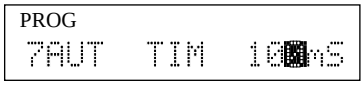


Step 2: Press the [ENT] key.
The operation automatically proceeds to the invalidation period setting.

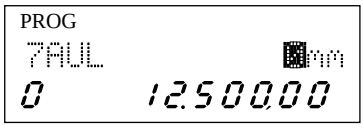


Step 3: Set the invalidation period to 100 ms.

[1] [0] [0]

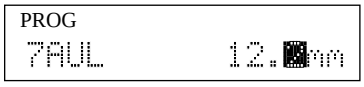


Step 4: Press the [ENT] key.
The operation automatically proceeds to the lower detection limit setting.

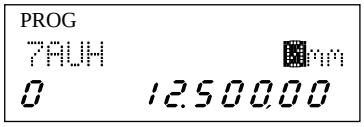


Step 5: Set the lower detection limit to 12.2 mm.

[1] [2] [.] [2]



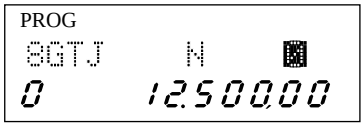
Step 6: Press the [ENT] key.
The operation automatically proceeds to the upper detection limit setting.



Step 7: Set the upper detection limit to 12.8 mm.

[1] [2] [.] [8]

Step 8: Press the [ENT] key.
The operation automatically proceeds to the group judgment setting.



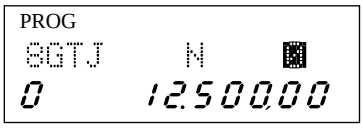
4.5.3.9 F8: Setting the group judgment

Set the conditions for the group judgment here.

Select between 0 and 99 for group size (0 and 1 are used for not performing group judgment).

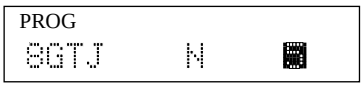
In this example assume that the group size is 5, and the objective statistical item is mean.

Step 1: The previously set group size is flashing.

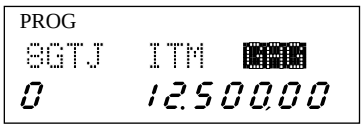


Enter "5" as the group size.

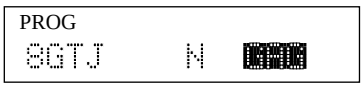
5



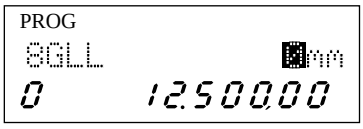
Step 2: Press the ENT key.
If 0 or 1 is set for the group size in step 1 above, the operation automatically proceeds to the segment setting, which is the first stage of this function setup. Otherwise proceeds to the statistical setting.



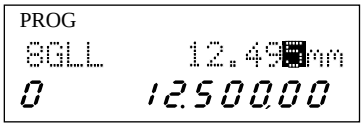
Step 3: Select the objective statistical item, Each time the ∧ key is pressed, the setup option will change in the following order: [redacted] → [redacted] → [redacted] → [redacted]. Since "mean" is to be set in this example, no key input is necessary at this step.



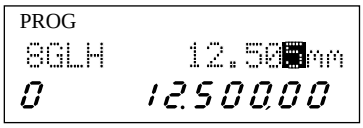
Step 4: Press the ENT key.
The operation automatically proceeds to the group lower limit setting.



Step 5: Set the group lower limit in the manner similar to that of the lower limit setting. Press the ENT key and the operation automatically proceeds to the group upper limit setting.



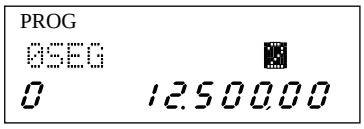
Step 6: Set the group upper limit in the manner similar to that of the upper limit setting. Press the ENT key and the operation automatically proceeds to the segment setting, which is the first stage of this function setup.



4.5.3.10 Confirming the function setup contents

Every setting that has been made in the function setup mode can be confirmed using the [ENT] key without affecting the existing setup data.

Step 1: In the ready state press the [SET] and [ENT] keys to enter the segment setup mode.



Step 2: Each time the [ENT] key is pressed, each piece of setup data for segments through group judgment will be displayed sequentially. Record these data in the List of Function Setups, at the end of this user's manual.

Step 3: Press the [SET] key twice to return to the ready state.

5 MEASUREMENT MODE

Perform your measurement according to the basic setup and measuring conditions specified.

This chapter describes the items which can be set in the ready state and gives measurement examples.

5.1 Outline of the Measurement Mode

The measurement mode includes the ready state, single-run measurement mode, and continuous-run measurement mode.

1) Ready state
The BUSY LED flashes each time the measurement is performed.

2) Single-run measurement
The RUN LED stays lit from the start of measurement until the display latch timer expires, and the BUSY LED turns on each time the measured data is updated.

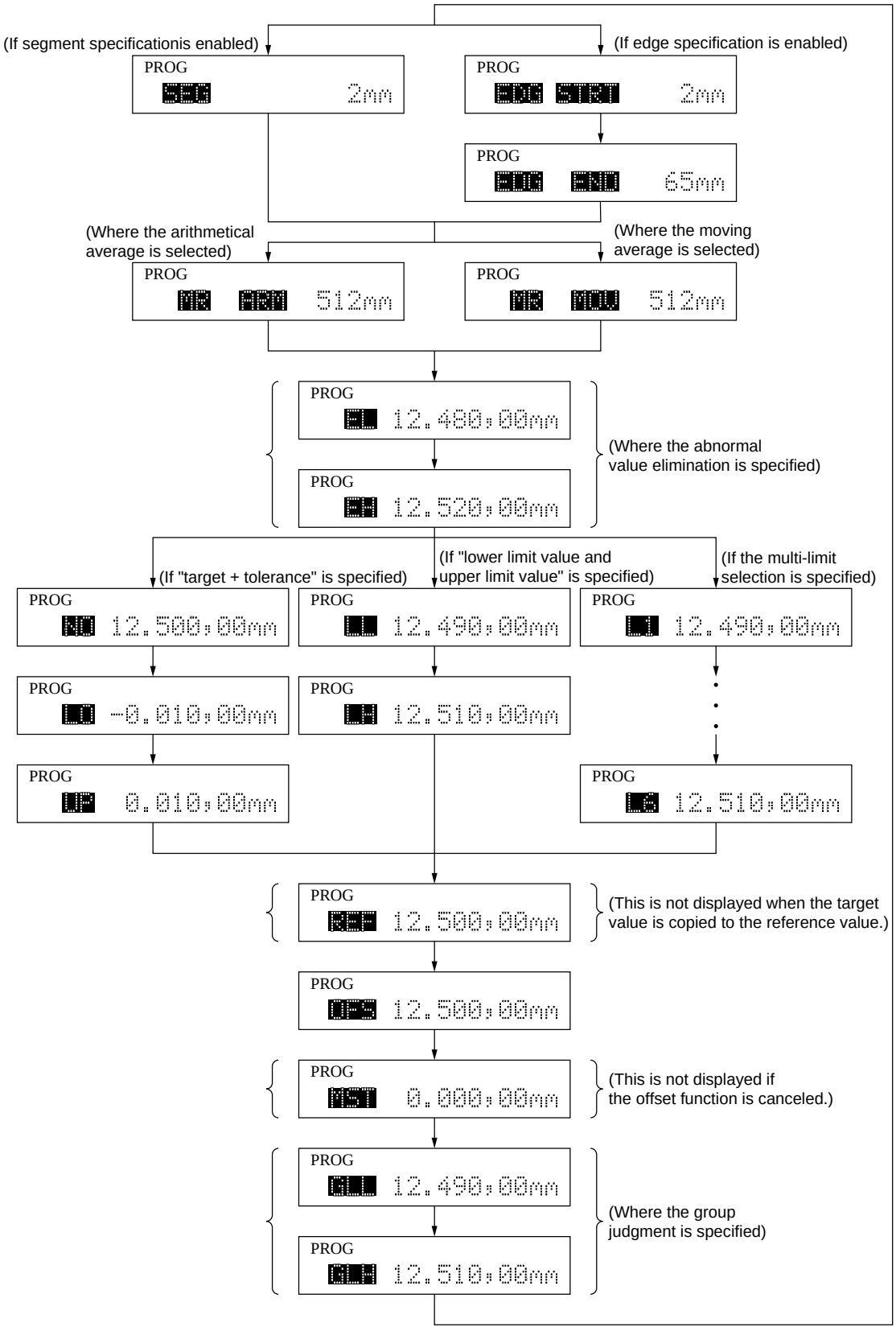
3) Continuous-run measurement
The RUN LED turns on if measurement starts and stays on during repeated measurements. The BUSY LED turns on each time the measured data is updated. When measurement is terminated the measured data is latched on the display and the RUN LED turns off when the display latch time expires.

5.1.1 Setup in the measurement mode

- This system employs a 2-section display unit, which enables continuous display of setup values while measurements are being made. Also, it provides a simple method for modifying the setup values.
- The setup mode of the specific setup items can be entered either by using the arrow key ([<]) or by pressing the corresponding item keys directly.

5.1.1.1 Setup operation from the arrow key

If the < key is pressed in the ready state, the setup operation will progress in the following way. The displayed contents will vary depending on the basic setup.



• The setting procedure is as follows:

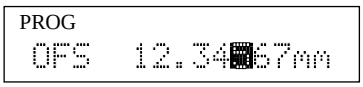
Step 1: Press the [<] key in the ready state to enter the setup mode.

Step 2: Each time the [∧] key is pressed, the setup guidance for each setup item changes in the following order: [redacted] ([redacted] → [redacted]) → [redacted] ([redacted]) → ([redacted] → [redacted]) → [redacted] → [redacted] ([redacted] → • • • [redacted] or [redacted] → [redacted] → [redacted]) → ([redacted]) → [redacted] → ([redacted]) → ([redacted] → [redacted]). Press the [ENT] key when the desired setup option is flashing. Press the [∨] key to reverse this order.

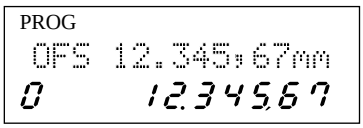
Step 3: Modify the setup data. The method used to enter data is the same as that used in the function setup mode.
For practice, modify the offset value from 12.5 mm to 12.34567 mm.
The previously set data is displayed and its least significant digit is flashing.

Enter “12.34567”.

[1] [2] [.] [3] [4] [5] [6] [7]

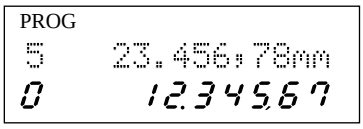


Step 4: Press the [ENT] key to initiate the following operation flow: Measure a reference gage, execute the compensation calculation, save the setup data in memory, then return to the ready state.
If the insertion of a comma after the thousandth digit has been specified in the basic setup, the comma will be automatically inserted.



(In single measurement)

For a single measurement the most recent setup item will always be displayed in the upper section of the display unit. However, the upper section of the display unit shows a background measurement in the simultaneous measurement.



(In simultaneous measurement)

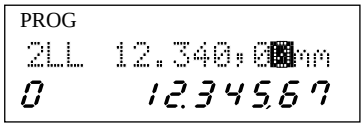
TIP

1. In simultaneous measurement the upper section of the display unit shows a background measurement. However, the setup mode for the foreground program can be entered by pressing the [<] key.
2. In single measurement, if an important setup item being displayed in the upper section of the display unit is retained, confirmation of the measuring object and modification of the setup data is easy.
3. If the [SET] key is pressed halfway in the setup operation, the operation is suspended and the ready state is restored. This can be used to confirm the setup data.
4. The last setup item made will be displayed first.

5.1.1.2 Setup that can be made directly from each setup item key

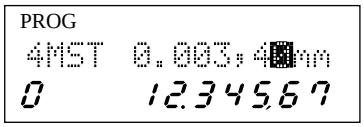
The user can enter the specific setup mode by pressing the corresponding setup item key ([LIMIT], [SHIFT] [MASTER]/[OFFSET], [REF], or [LOCK]/[UNIT]) in the ready state.

1) [LIMIT] key



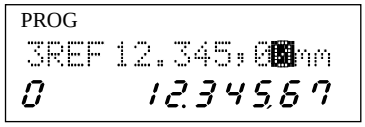
This key is used to enter the setup mode for only the GO/NG judgment function.
If the [ENT] key is pressed after the setup data is entered, the set up data will be saved in memory and operation will return to the ready state. If the [LIMIT] key or [SET] key is pressed halfway in the setup operation, the setup operation is aborted, and operation returns to the ready state.

2) [SHIFT] + [MASTER]/[OFFSET] key



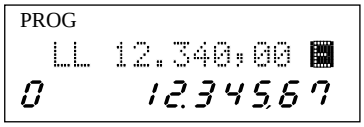
This key combination is used to enter the setup mode for only the mastering function.
If the [ENT] key is pressed after the setup data is entered, the set up data will be saved in memory and operation will return to the ready state. If the [MASTER]/[OFFSET] key or [SET] key is pressed halfway in the setup operation, the setup operation is aborted, and operation returns to the ready state.

3) [REF] key



This key is used to enter the setup mode for only the reference value.
If the [ENT] key is pressed after the setup data is entered, the setup data will be saved and the operation will return to the ready state. If the [REF] key or [SET] key is pressed halfway in the setup operation, the setup operation is aborted, and operation returns to the ready state.

4) [LOCK]/[UNIT] key



This key is used to enter the modification mode of the unit of measurement. If the metric unit is currently being used, mm will be flashing; and if the E unit is currently being used, inch will be flashing.
If the [ENT] key is pressed, the unit is changed to that which is currently flashing, then operation returns to the ready state.
If the [LOCK]/[UNIT] key or [SET] key is pressed halfway in the setup operation, the setup operation is aborted, and operation returns to the ready state.

The metric to E (1 E = 25.4 mm) conversion table is shown below.

mm	0.00001	0.00002	0.00005	0.0001	0.0002	0.0005
E	.000001 *	.000001	.000002	.000005	.00001	.00002

mm	0.001	0.002	0.005	0.01	0.1	–
E	.00005	.0001	.0002	.0005	.005	–

Note 1: Theoretically, conversion of a value with an asterisk ("*") into the E system results in a value of .0000005. On this LSM, the value will be converted into a resolution of .000001.
Note 2: For information about the resolutions that can be selected refer to Section 4.1.2.1, "B0 mode".

5.2 Other Functions

From the ready state it is possible to activate the following modes.

5.2.1 Key lock

Press the SHIFT and LOCK/UNIT keys to activate the key lock mode. Subsequently, key operations other than SHIFT and LOCK/UNIT keys will not be accepted. To cancel this mode, press the same keys again.

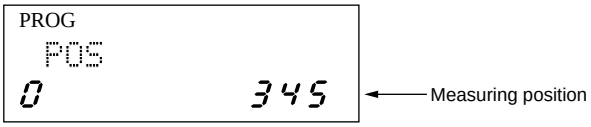
However, if the key lock mode is initiated by the "LOCK" command from the RS-232C interface, it can not be canceled by any key operation.

The only way the key lock mode is canceled is by turning the power off.

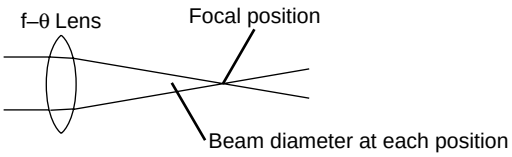
5.2.2 Displaying the measuring position

- If the SHIFT and READ keys are pressed in the ready state, the measuring position (focal position) display mode is entered. The ready state can be returned to if the READ key or SET key is pressed.

- The displayed value is not defined, but a value that is proportional to the beam diameter at the measuring position.
  Since the measurement is defined at the focal position where the displayed value is the smallest, take measurements at a position as close to the focal position as possible.
  If the measured position is off the focal position, the measurement accuracy will be reduced.



- Beam diameter at each position
  The laser scanning beam is stopped down so that it has a minimum diameter at the measurement position (focal position). Since the beam diameter gets thicker the farther it gets from the focal point, the repeatability will be reduced if measurements are taken far out.
  Therefore, always perform measurement at the focal position.



- Check the measurement position in the up/down direction with the W.P. LED.

5.3 Applied Measurement

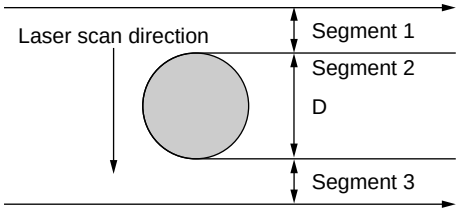
Perform measurement according to the conditions set.

This section gives example operations for a better understanding of the versatile functions of this instrument.

For information about actual setup methods refer to Section 3.4, “Outline of Key Operations”, Section 4.1, “Basic Setup”, and Section 4.5, “Setting up the Functions”.

5.3.1 OD measurement of a precision-machined workpiece

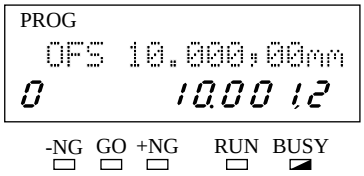
Perform a single-run measurement and make a GO/NG judgment of the workpiece OD.



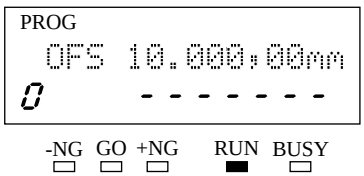
- Suppose that D = $10^{\pm 0.002}$ mm.
- Set the following:
  1. Segment = 2
  2. Number of scans for averaging = 512 or more
     For precision measurement set a large value.
  3. GO/NG criteria
     a. Lower limit value = 9.998 mm
     b. Upper limit value = 10.00201 mm
     (If 10.002 mm is accepted as GO, add the resolution to this value. This also applies to the following examples.)

- Measurement

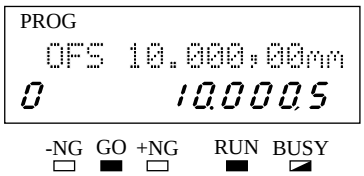
  1. Perform measurement in the ready state.
     The GO/NG LEDs and RUN LED are off, and the BUSY LED turns on for each measurement.



  2. Start a single-run measurement. “ - - - - - - - ” will be displayed in the lower section of the display unit. Also, the RUN LED lights and stays lit.



  3. After the set measurement interval (approximately 0.32 seconds, for 512 times averaging), the BUSY LED lights for a moment, then the measured data is latched on the display.
     The measured data is subjected to GO/NG judgment, and the result will be outputted on the GO/NG LEDs. It will also be, depending on the setup, outputted to the RS-232C (printer) and Digimatic Code Output Unit.



TIP About the number of scans for averaging and repeatability
If high accuracy is required, select the largest number of scans for averaging possible.
In general, doubling the number of scans for averaging improves repeatability by 1.4 times.

5.3.2 Measurement of magnet coil wire that runs at high speed

This instrument makes 1600 scans per second, which makes it possible to make high accuracy measurements of workpieces that move at high speed and vibrate.

In the wire drawing process or coating process in which the wire OD must be precisely controlled, it is usual to feed back the OD measurement data so that the diameter of the wire can be controlled to within the tolerance limits. To avoid a significant change in the feedback, it is most common to use the moving average.

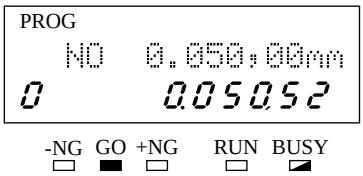
Below is an example of magnet coil wire with a diameter of ø0.05 $^{\pm 0.001}$ mm (50 ± 1 µm):

- **Basic setup**
  1. GO/NG judgment in the ready state
     Specify that GO/NG judgment be performed in the ready state.
  2. Averaging method
     Specify the moving average.
  3. Method of GO/NG judgment
     Specify (target value + tolerance)
     In addition, set so that the target value can be copied onto the reference value.
  4. Other settings
     Set as required for the operation environment.

- **Function setup**
  1. Segment = 2
  2. Number of scans for averaging = 512 (or, 1024 or 2048 times)
  3. GO/NG judgment
     a. Target value = 0.05 mm
        The same value will be automatically set for the reference value.
     b. Lower tolerance limit = -0.001 mm
     c. Upper tolerance limit = 0.001 mm

- **Measurement**

  If the power is on, measurement automatically starts after the internal error checks have been performed. The measured data will be displayed. At the same time the GO/NG judgment result will be outputted for the GO/NG LEDs.



5.3.3 Measurement of the lead pitch of a multiple-pin IC

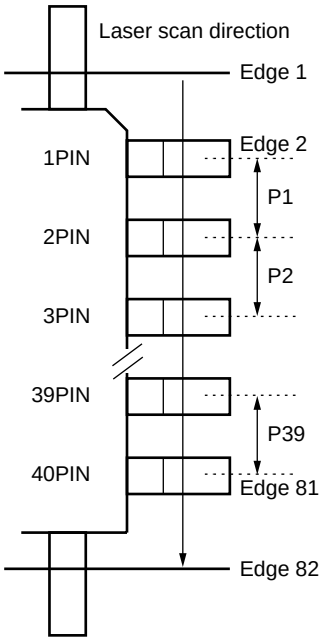
If the edge specification is made, it is possible to measure a dimension between two optional edges from between 1 and 255 edges. This can be applied to inspecting the IC lead bend and measurement of the head gap of an HDD.

Below is an example where the IC lead bend of a 160-pin flat package IC must be checked using the automatic workpiece detection function. Assume that the pin thickness and lead-to-lead interval are identical according to the specification.

The following IC specifications are used: 40 leads are on one side, the lead-to-lead interval is 0.635 mm (1/40"), the pitch tolerance is 0.01 mm.

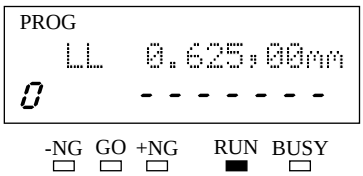
- **Basic setup**
  1. Segment specification
     Specify the edge specification method.
  2. Automatic workpiece detection
     Specify use of automatic workpiece detection.

- **Function setup**
  1. Segment
     a. Start segment = 2
     b. Finish segment = 81
        (Last lead number x 2 +1)
  2. Number of scans for averaging = 32
  3. GO/NG judgment
     a. Lower limit = 0.625 mm
     b. Upper limit = 0.645 mm
  4. Setting automatic measurement
     Specify the pitch measurement.
  5. Automatic workpiece detection setup
     Measurement time = 1
     Invalidation period = 20 ms
     Lower detection limit = 0.6 mm
     Upper detection limit = 0.67 mm

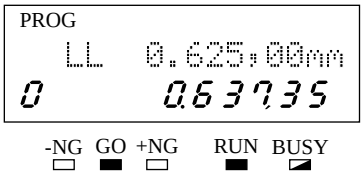


- **Measurement**

Press the C.RUN key.
" - - - - - - - - " is displayed and continuous-run measurement starts.
Provided that edges 1 through 82 are detected within the measuring region and that the measurements of the edges 2 and 3 are within the detection range, the system recognizes the workpiece presence and starts actual measurements after the elapse of invalidation period.



In approximately 0.82 second after the invalidation period the measured data will be displayed.
If the tolerancing judgment result is "GO", the mean value is displayed.
If the judgment result is "±NG", the number of the pin pitch where "±NG" was detected for the first time is also displayed.



If the next objective IC enters the measuring region, it is automatically detected and measurement will be repeated.

TIP

1. Measurement time of automatic measurement
   { (Number of objective leads of measurement) x (Measurement interval) + (calculation time: 20 ms)} = (40 x 20 + 20) ms = 0.82 second.
2. If GO/NG judgment is ±NG
   The ±NG measurement data, which is detected first, is displayed and the judgment result is outputted. Subsequent measurement is stopped.
3. For the automatic workpiece detection on IC or connector measurement, the part (PIT, DIA, GAP) of the smallest edge number (falls on pin No.1) is used for detection, if the diameter-detection method is specified.
   With the position-detection method measurement starts when the smallest edge is detected.

IMPORTANT

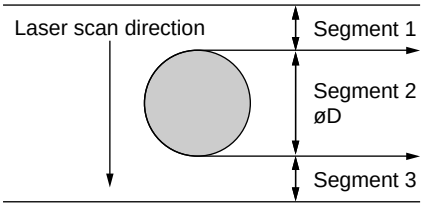
About automatic measurement of a moving workpiece
For automatic measurement on a multi-pin IC, etc., this instrument will sequentially perform measuring from the smallest edge number in the scanning range. For this reason, if any edge moves outside the scanning range during measurement, the edge number will change, resulting in incorrect measurement. Therefore, allow a sufficient measuring time including the invalidation period for automatic measurement.
If possible, take measures so that the workpiece stops within the measuring region.

5.3.4 Applied Measurement with Offset/Zero-Set Functions

1. Applied measurement with offset function 1

The offset function can be applied for converting the reference gage dimension to a nominal dimension (Figure a).

In Figure a set the offset direction to “0” (positive).



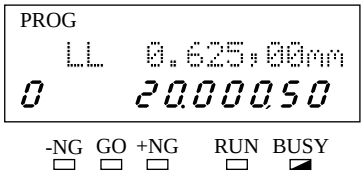
[Figure a]

Example of [figure a]

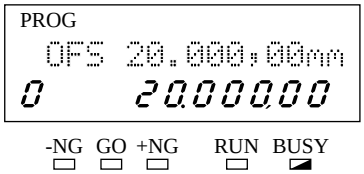
Let D = $20.0005^{\pm 0.0015}$ mm

- **Basic setup**
  Set up according to the requirement.
- **Function setup**
  1. Segment = 2
  2. Number of scans for averaging = 512
  3. GO/NG judgment
     a. Lower limit
        = 19.9985 mm
     b. Upper limit
        = 20.0015 mm
  4. Offset
     a. Set the nominal dimension of the gage to 20.0 mm.
     b. Direction = 0 (positive)
- **Measurement**

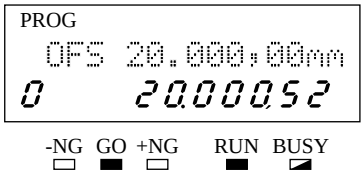
The ready state display appears as shown at the right before the offset is set.



If the offset value is set to 20.0 mm, the guidance display for the OFFSET guidance indicator (▼) turns on, and the measurement is also replaced to 20.0 mm.



Press the [RUN] key.
“ - - - - - - - - ” is displayed and single-run measurement starts.
After the first measurement interval the measurement value is displayed, and the GO/NG judgement result is outputted.



TIP
1. To re-activate the offset function using the existing offset value and direction, press the [MASTER]/[OFFSET] key. With this single key operation, offset can be achieved.
2. It is possible to obtain a deviation from the reference gage by offsetting (zero-setting) it to “0.0”.

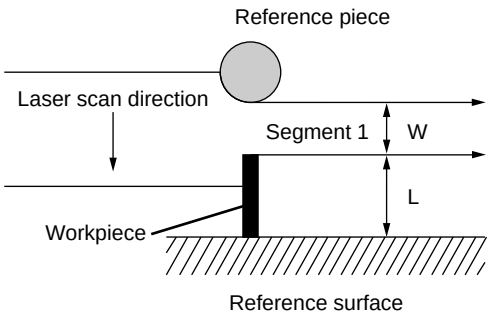
2. Applied measurement with offset function 2

The offset function is used to measure a workpiece larger than the measuring range of this system.

In Figure b set the offset direction to “1” (negative).

Example of [figure b]

Let L = 50.0 $^{\pm 0.01}$ mm



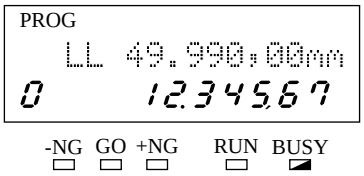
[Figure b]

- **Basic setup**
  Set up according to the requirement.

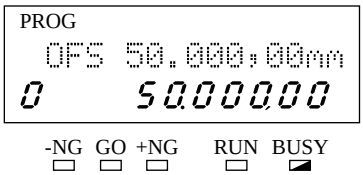
- **Function setup**
  1. Segment = 1
  2. Number of scans for averaging = 512
  3. GO/NG judgment
     a. Lower limit = 49.99 mm
     b. Upper limit = 50.01 mm
  4. Offset
     a. Set to 50.0 mm.
     b. Direction = 1 (negative)

- **Measurement**

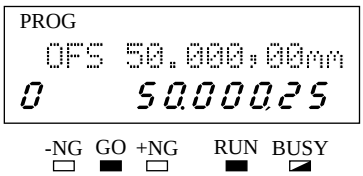
  The ready state display appears as shown at the right before the offset is set.
  Since the offset has not been set, the gap of segment 1 is measured.



  Set the offset to 50.0 mm. The measurement value is also replaced by 50.0 mm.
  As the gap measurement is selected, set here the negative direction (1).



  Press the [RUN] key.
  “ - - - - - - - ” is displayed and single-run measurement starts.
  After the first measurement interval the measured value is displayed, and the GO/NG judgment result is outputted.



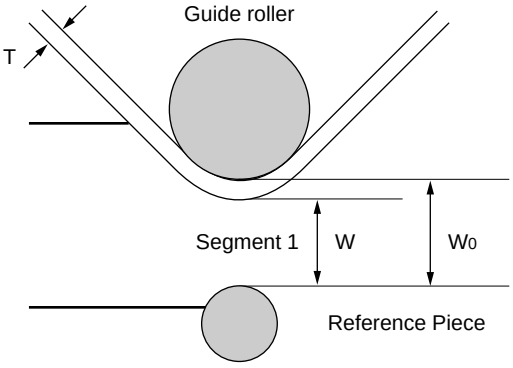
3. Applied measurement with the zero-set function

Use the zero-set function to easily measure a tape thickness.

First measure segment 1 (W_0) after removing the tape from the guide roller, which is used as a reference gage.

Set the tape as the measurement objective on the guide, then measure segment 1 (W). The tape thickness (T) is obtained from: $T = (W_0 - W)$

For this measurement use the zero-set function.



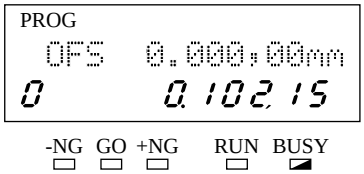
[figure c]

Convert (zero-set) W_0 to 0.0 mm and set the direction as 1 (negative). The following results: $T = \{W_0 - (-W)\} = 0.0 - (-W) = W$

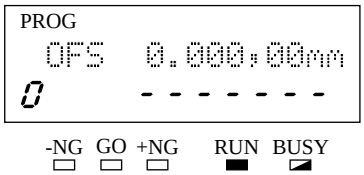
Here is an example of measuring a tape with a thickness of $T = 0.1^{\pm 0.005}$ mm.

- **Basic setup**
  Set up as required.
- **Function setup**
  1. Segment = 1
  2. Number of scans for averaging = 128
  3. GO/NG judgment
     a. Lower limit = 0.095 mm
     b. Upper limit = 0.105 mm
- **Measurement**

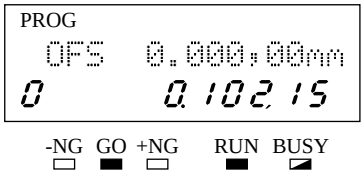
  Remove the tape and offset (zeroset) with “0.0”.
  Then set up the tape.
  The tape thickness will be displayed, however, GO/NG judgment is not performed.



  Press the C.RUN key.
  “ - - - - - - - ” is displayed and continuous-run measurement starts.



  At every measurement interval the measured data is displayed, and the GO/NG judgment result is outputted.
  Press the RUN key or C.RUN key.
  The most recent measurement is displayed, and measurement is stopped.



5.3.5 Sample measurement

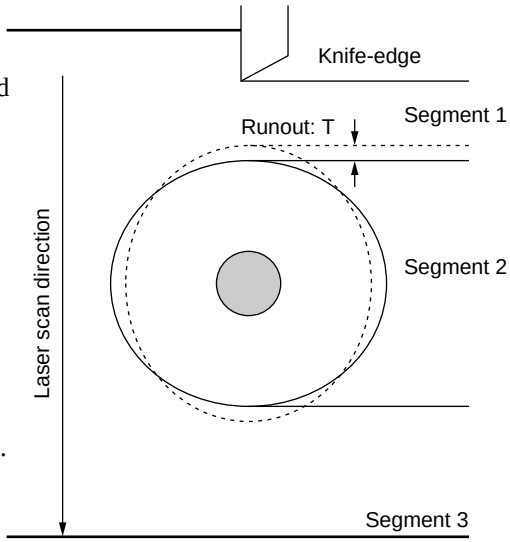
In addition to the diameter, a roller in a paper-feed mechanism requires a high machining accuracy with respect to both the roundness and cylindricity.

In this example suppose that the roller is being turned to measure the runout.

In the diagram at the right the roller is turning, and the gap of segment 1 is measured to determine the runout of T while segment 2 is measured to determine the OD.

This runout can be derived from the range (maximum - minimum) of sample measurements.

In this example a knife-edge is used for stable gap measurement, however, a round pin can also be used if appropriate.



Here is an example of measuring a rubber roller with a diameter of ø25.0 $^{\pm 0.05}$ mm and a runout tolerance of T = 0.03 mm.

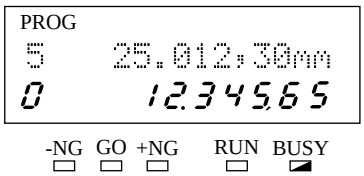
- **Basic setup**
  Specify simultaneous measurement.
- **Function setup**

Setup item	Program0 (Foreground)	Program5 (Background)
Segment	1	2
Number of scans for averaging	32	32
Lower limit value	0.0	24.95
Upper limit value	0.03	25.05
Number of sample	50	50
Statistical item	range (maximum value - minimum value)	mean

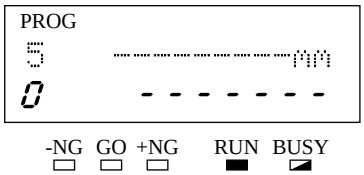
NOTE: The rubber roller must be turned more than 360 degrees. Number of scans for averaging is determined from the revolution speed and the sample number.

- **Measurement**

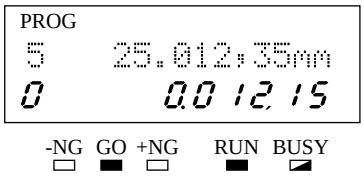
In the ready state the gap dimension of segment 1 is displayed.



Press the RUN key to start the measurement.
" - - - - - - - " is displayed and the sample measurement starts.

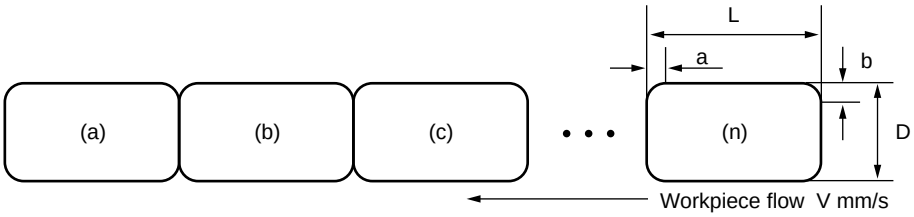


In this example the measurement result will be displayed and the GO/NG judgment result will be output approximately 1 second after measurement starts.



5.3.6 Applied measurement with automatic workpiece detection

If a workpiece of the specified range of dimension enters the measuring region, measurement will be automatically started.



D = 5.0 $^{\pm 0.0015}$ mm, L = 12 mm, chamfer a = 0.5 mm, b = 0.5 mm, and V = 50 mm/s.

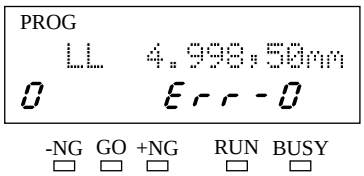
- **Basic setup**
  Select the OD detection method for automatic workpiece detection, and specify 16 for the detecting speed (number of scans).

- **Function setup**
  1. Segment = 2
  2. Number of scans for averaging = 256
     Set to the maximum value of (Measurement interval) < (L- 2a) / V.
  3. GO/NG judgment
     a. Lower limit = 4.9985 mm
     b. Upper limit = 5.0015 mm
  4. Automatic workpiece detection
     a. Number of measurements n = 1
     b. Invalidation period t = 50 ms
        t > (a / V)
     c. Lower detection limit L = 4.9 mm
        Set using the dimension excluding the chamfered portion.
     d. Upper detection limit H = 5.1 mm

NOTE About automatic workpiece detection
If sequentially fed workpieces have a small chamfer and they are almost in contact, workpieces may not be clearly identified. If this is the case, use connection rods, for example, for adequate intervals.
In addition, allow a sufficient margin for the invalidation period and upper and lower detection limits.

- **Measurement**

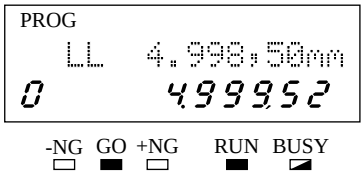
The diagram at the right indicates that no workpiece is present in the measuring region in the ready state.



Press the C.RUN key to start continuous measurement while changing the display from "Err-0" to "- - - - - - - -." If workpiece (a) enters the measuring region, OD measurement will automatically be started.

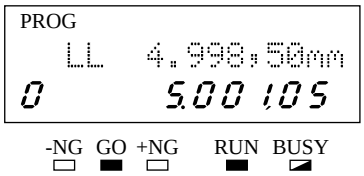
If the OD measurement resulting from 16 scans is within the preset limits, a workpiece is judged as being present ("workpiece present"). The system waits until the specified invalidation period elapses.

After the invalidation period elapses, OD measurement of workpiece (a) is started. At every measurement interval the measured data will be displayed and the GO/NG judgment results will be output.

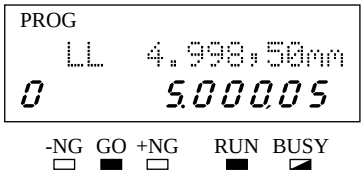


Measurement of workpiece (b) entered.
As with workpiece (a) measurement is performed and the results are displayed.

Workpieces that enter the measuring region are measured sequentially.

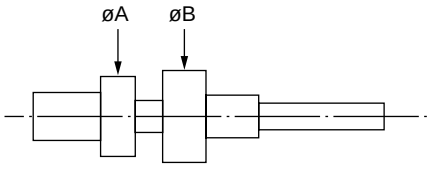


To terminate measurement, press the RUN key or C.RUN key again.
The most recently measured data will be displayed.



5.3.7 Applied measurement on a stepped round bar

In this example 10 stepped round bars are measured and the results are statistically processed. If ±NG measurement is obtained, it will be automatically printed out.
In the figure at the right suppose the following:
øA: ø6 $^{\pm 0.01}$ mm
øB: ø10h7$^{0}_{-0.015}$ mm



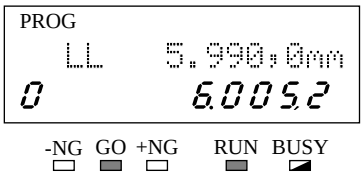
- **Basic setup**
  1. Set the resolution to 0.1 µm.
  2. Specify the RS-232C port as the printer port.

- **Function setup**

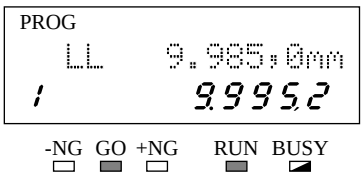
Setup item	Program0 (Foreground)	Program1 (background)
Segment	2	2
Number of scans for averaging	512	512
Lower limit value	5.99	9.985
Upper limit value	6.01	10.0
Data output condition	2	2
Other condition	0 (cancel)	0 (cancel)

- **Preparation for measurement**
  Press the [SHIFT] and [A.CL]/[M.CL] keys to clear all of the statistical memory, then press the [STAT]/[S.E] key to start statistical processing. If the statistical processing mode is entered, the S.E. guidance indicator (▼) turns on.

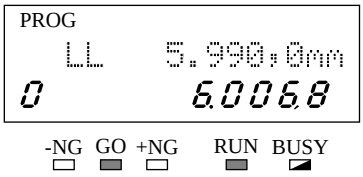
- **Measurement**
  Perform a single-run measurement for the A dimension by program No.0 after setting the workpiece in place. The measured data will be displayed and the GO/NG judgment result will be outputted.



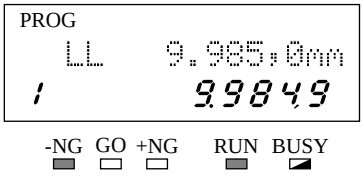
  Change to Program No.1 for the B dimension to be measured through single-run measurement.
  The measured data will be displayed and the GO/NG judgment result will be outputted.



  Change the workpiece and repeat the same measurements.

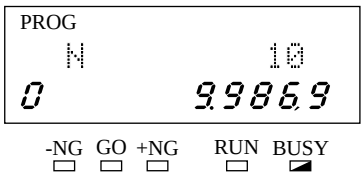


  If the result is ±NG, it will be automatically printed out.



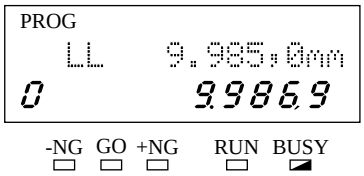
- **Confirming the statistical data on the display (not always required)**

  Press the SHIFT and STAT/S.E keys in the ready state to enter the statistical display mode for Program No.0. If this mode is entered, the number of samples is displayed first.



  Each time the ENT key is pressed, the statistical processing item changes in the following order: Number of samples: N → Standard deviation: S.D → Maximum value: MAX → Minimum value: MIN → Mean: AVG → Range: R → Number of samples: N.

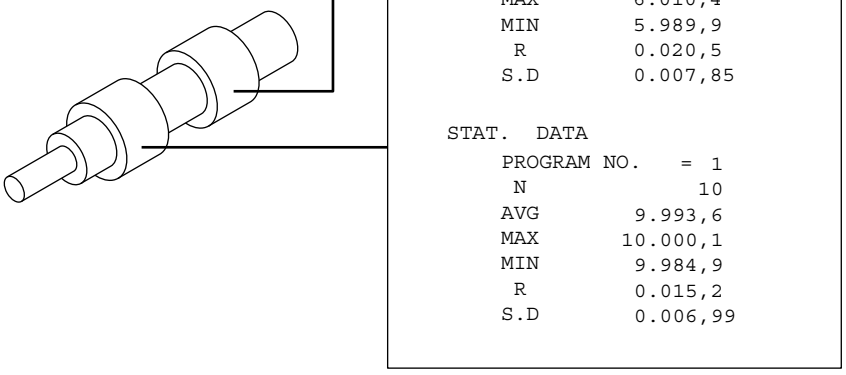
  Press the SHIFT and STAT/S.E keys to return to the ready state, and confirm the statistical data of Program No.1 in the same way.



- **Printing the statistical data**

  Use the SHIFT and S.PR/PRINT keys to print out the statistical data. This automatically clears all of the statistical memory after printout.
  An example printout is shown below.

An example printout



```
P:0    -NG     5.989,9
P:1    -NG     5.984,9
P:0    +NG     6.010,1
P:1    +NG    10.000,1
STAT.  DATA
     PROGRAM NO.   = 0
      N              10
     AVG        6.003,2
     MAX        6.010,4
     MIN        5.989,9
      R         0.020,5
     S.D        0.007,85

STAT.  DATA
     PROGRAM NO.   = 1
      N              10
     AVG        9.993,6
     MAX       10.000,1
     MIN        9.984,9
      R         0.015,2
     S.D        0.006,99
```

6 INTERFACE UNIT

This chapter describes the setup method and functions provided with the RS-232C interface and Digimatic output interface of this unit.

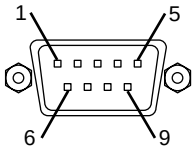
6.1 RS-232C Interface

The standard RS-232C interface of this Display Unit allows the LSM to communicate with external devices via RS-232C (EIA standard) serial signals.

Prior to using this interface , set up the baud rate, data bits, and parity check, etc. according to Section 4.1, “Basic Setup”. The setting contents must be compatible to that on the external device to be connected.

6.1.1 Specifications

- Applicable plug connector: D-sub 9 pin (female) (Manufacturer: AMP, HD-20/747951-1) or equivalent.



The pin numbering for this system is shown at the left

- Communication specifications

Device definition	Specify the LSM as a terminal (DTE)	
Communication method	Full-duplex	
Synchronizing method	Start/stop method (asynchronous)	
Baud rate	1200, 2400, 4800, 9600, 19200 bps	
Data configuration	Transmission code	ASCII
	Data bits	7 or 8 bits
	Start bit	1 bit
	Stop bit	1 bit
	Parity check	None, odd, or even
	Delimiter	CR+LF, CR, LF

NOTE
1. The shaded settings are the factory defaults.
2. In the above table “none parity” can not be selected if the data bits are 7 bits in length. In this case, set the parity to either odd or even, or set the data bits to 8 bits.

TIP
1. DTR and RTS signals from the LSM will be ON immediately after power on.
2. DSR signals to the LSM are always ignored.
3. The transmitter-receiver inside the LSM uses a µPD4723 (Manufacturer: NEC).

6.1.2 Connections

(1) Connecting the RS-232C interface to a device specified as a terminal (DTE)

Example 1 Flow control method (handshake method controlled by CTS, DSR, DTR, and RTS signals)

Personal computer (PC-AT compatible) specified as a terminal (DTE)

Signal name	Pin No.
DCD	1
RxD	2
TxD	3
DTR	4
SG	5
DSR	6
RTS	7
CTS	8
RI	9

9-pin D-sub

LSM: specified as a terminal (DTE)

Pin No.	Signal name
1	
2	RxD
3	TxD
4	DTR
5	SG
6	DSR
7	RTS
8	CTS
9	

9-pin D-sub

Example 2 Flow control method (handshake method controlled by CTS, DSR, DTR, and RTS signals)

Personal computer (PC-9801) specified as a terminal (DTE)

Signal name	Pin No.
FG	1
TxD	2
RxD	3
RTS	4
CTS	5
DSR	6
SG	7
DCD	8
DTR	20

25-pin D-sub

LSM: specified as a terminal (DTE)

Pin No.	Signal name
1	
2	RxD
3	TxD
4	DTR
5	SG
6	DSR
7	RTS
8	CTS
9	

9-pin D-sub

Example 3 3-Wire method (teletype protocol using TxD, RxD and SG)

Personal computer (PC-AT compatible) specified as a terminal (DTE)

Signal name	Pin No.
DCD	1
RxD	2
TxD	3
DTR	4
SG	5
DSR	6
RTS	7
CTS	8
RI	9

9-pin D-sub

LSM: specified as a terminal (DTE)

Pin No.	Signal name
1	
2	RxD
3	TxD
4	DTR
5	SG
6	DSR
7	RTS
8	CTS
9	

9-pin D-sub

(2) Connecting the RS-232C interface to a device specified as a modem (DCE)

Example 1 Flow control method (handshake method controlled by CTS, DSR, DTR, and RTS signals)

Device specified as a modem (DCE) — LSM: specified as a terminal (DTE)

Signal name	Pin No.
DCD	1
RxD	2
TxD	3
DTR	4
SG	5
DSR	6
RTS	7
CTS	8
RI	9

9-pin D-sub

Pin No.	Signal name
1	
2	RxD
3	TxD
4	DTR
5	SG
6	DSR
7	RTS
8	CTS
9	

9-pin D-sub

Example 2 DPU-414: Printer (controlled by RTS signal)
The DPU-414 series printer (Manufacturer: Seiko Electronics Co., Ltd.) should be connected as follows:

DPU-414 series printer — LSM: Defined as terminal (DTE)

Signal name	Pin No.
	1
TxD	2
RxD	3
*1	4
SG	5
*1	6
	7
RTS	8
	9

9-pin D-sub

Pin No.	Signal name
1	
2	RxD
3	TxD
4	DTR
5	SG
6	DSR
7	RTS
8	CTS
9	

9-pin D-sub

*1: Pin Nos. 4 and 6 of the printer-side connector are internally connected.
*2: Possible to use a straight-type cable (In this case, it is not necesary to install wirings shown by the dotted lines) .

IMPORTANT

1. The signals names and pin assignment described here may be different from that of the user's devices. Refer to the user's manual of your own device when making connections.
2. For this connection always use cables that have a shielding net. Both ends of this shielding net should be connected (grounded) to the RS-232C connector case. Without using a shielded-wire this system may experience electrical interference resulting in operation errors. Or, radio frequency will be emitted from this system and interfere the electrical equipment such as TVs, etc.

6.1.3 Printer interface

6.1.3.1 Setting the printer

- RS-232C can be set as a printer port in the basic setup mode.
- DPU-414 series printers from Seiko are compatible.
- Use a supplied connection cable which comes with the printer.
- DPU-414 series printer setup (Refer to the DPU-414 operation manual: the section 2.3, “Functions setup” on the page 15 through 20.)

1) Software Dip Switches Setup

Set the DIP SW 1 to 3 as shown bellow.

SW1 :	1	2	3	4	5	6	7	8	
	0	1	1	0	1	0	1	1	(1 : on, 0 : off)
SW2 :	1	2	3	4	5	6	7	8	
	1	1	1	1	1	1	1	1	(1 : on, 0 : off)
SW3 :	1	2	3	4	5	6	7	8	
	1	1	1	1	0	1	1	1	(1 : on, 0 : off)

2) The method of Software Switches setup

a. Switch on the power while pressing the [ON LINE] key, releasing it when printing is started. Current setup condition will be printed out.

b. Press the [ON LINE] key. “Dip SW-1” is printed out. Set the DIP SW 1: bit 1 to 8 here.

NOTE
- Complete setting of DIP SW 1: bit 1 to 8 at a stretch. Don’t stop it halfway.
- [FEED] key and [ON LINE] key are assigned to “0” (off) and “1” (on) for setting respectively.

Press both [FEED] and [ON LINE] keys in order as specified bellow.

	[FEED]	[ON LINE]	[ON LINE]	[FEED]	[ON LINE]	[FEED]	[ON LINE]	[ON LINE]
(Print)	0	1	1	0	1	0	1	1

c. When setting DIP SW 1: bit 1 to 8 is complete in the item b., “Continue? :Push ‘On-line SW’ ”, “Write? :Push ‘Paper feed SW’ ” will be printed out. Then press [On LINE] key to proceed to setup DIP SW2. “Dip-SW-2” is printed out. Here, start setting of DIP SW2.

d. For DIP SW2 setting, press both [FEED] and [ON LINE] keys in order as specified bellow.

	[ON LINE]	[ON LINE]	[ON LINE]	[ON LINE]	[ON LINE]	[ON LINE]	[ON LINE]	[ON LINE]
(Print)	1	1	1	1	1	1	1	1

When setting DIP SW2: bit 1 to 8 is complete, same as item c. “Continue? :Push ‘On-line SW’ ”, “Write? :Push ‘Paper feed SW’” will be printed out. Then press [On LINE] key to proceed to setup DIP SW3. “Dip-SW-3” is printed out. Here, start setting of DIP SW3.

e. For DIP SW3 setting, press both [FEED] and [ON LINE] keys in order as specified bellow.

	[ON LINE]	[ON LINE]	[ON LINE]	[ON LINE]	[FEED]	[ON LINE]	[ON LINE]	[ON LINE]
(Print)	1	1	1	1	0	1	1	1

When setting DIP SW3: bit 1 to 8 is complete, press [FEED] key. DIP SW 1 to 3 setting will be complete.

6.1.3.2 Setting the LSM-9506

The following setting for LSM-9506 needs to be set in the Basic Setup mode and Setting Up the Functions mode.

1) Basic Setup (Refer to the section 4.1, “Basic Setup” and 4.1.2.5, “Selecting and setting the function in the B4 mode”.)

a. Setting the use of the RS232C port	RS-232C	:	PRN
b. Setting the RS232C communication baud rate	BAUD	:	9600
c. Setting the RS232C communication data bits	LENGTH	:	8
d. Setting the RS232C communication parity bit	PARITY	:	NONE
e. Setting the delimiter for communication	DELIMT	:	CR+LF
f. Setting the RS232C line control	CONTRL	:	USE

2) Setting Up the Functions (Refer to the section 4.5, “Setting Up the Functions” and 4.5.3.6, “F5: Setting the data output conditions”.)

DAT O.C : 1 (Printing for each measurement)
DAT TIM : 0 (Printing all)

Connect with the printer after setup is complete. Press [Print] key to start measurement and printing measured data.

6.1.4 RS-232C commands

- This section describes the reception commands used by the RS-232C interface and the response (transmission) commands that correspond to the reception commands. The data section of each command consists of ASCII codes.
- Use the following command subscriptions, symbols and supplement descriptions when you read Section 6.1.5, “List of commands”.
- Command symbols

Symbol		Meaning	Entry of numeral
sssssss aaa-bbb		Segment number Start edge and finish edge of the edge specification aaa: Start edge, bbb: Finish edge	Combination using numbers between 1 and 7 Select a number between 1 and 255 However, aaa should not be identical to bbb.
±ddd.dddd		Setup data or measured data	Maximum of 7 significant digits
p		Program Number	Select a number between 0 and 9
m		Measurement interval number	Select a number between 1 and 4
r		Data output condition	Select a number between 0 and 9
	ttt	Periodical output timer value (sec)	Select a number between 0 and 999
	tttt	Invalidation period of automatic workpiece detection (msec)	Select a number between 0 and 9999
nnn		Number of measurement times of sample measurement	Select a number between 0 and 999
	mmm	Number of measurement times of automatic workpiece detection	Select a number between 1 and 999
	nnnn	Number of scans for averaging	2^n(select between n=0 and 11)
nn		Group size subject to judgment	Select a number between 0, 1, 2 and 99
pp		SHL (Threshold level) specification (%)	Select between 50% and 90%
Δ		Space character	—

TIP

1. To ensure compatibility with the LSM-9506, this system ignores the following commands without treating them as ER6, but uses “OK”.
   - Memory switch command (UP0 uvxyz, UP1 uvxyz, UP2 uvxyz)
   - The MNL command is assumed to be identical to the MNH command.
2. If the setup data is “0”, it allows the corresponding function to be disabled. To set “0” as a numerical value, use “0.0”.
   Example 1 “SET, OF0” ..... Offset function is disabled.
   Example 2 “SET, OF0.0” ..... Offset function is enabled.
3. Setup data or measured data is denoted by ±ddd.dddd.
   - The first (most significant) digit is a sign. For commands that do not specifically designate the polarity, such as the calibration command, only a positive sign is accepted. However, these positive signs do not have to be specified.
   - Any decimal place is selectable.
     An integer can be entered without using a decimal point.
4. For making the setup operation of the measurement interval easier, use the measurement interval number as shown below. For the correspondence between the actual number of scans and the measurement interval numbers see the table below.

Measurement interval number	Measurement interval	Number of scans for averaging
1	0.01 sec	16 times
2	0.04 sec	64 times
3	0.16 sec	256 times
4	0.32 sec	512 times

5. “Pp” command can be appended to the following commands to be treated as a single command: “SET”, “R”, “CR”, “STAT”, “RP”.
   Example: P0, R
   P6, STAT

6.1.5 List of commands

Item		Reception command	Response command
LSM clear		CL	OK
Metric (mm) unit system E (inch) unit system		MM E	OK
Program number change		Pp	OK
Calibration	HIGH CAL set LOW CAL set	HC+ddd.dddd LC+ddd.dddd	OK
Segment	Segment specification Edge specification	SG sssssss SG aaa-bbb	OK
Setting the measurement interval number	Measurement interval number at arithmetical average Number of scans for averaging at arithmetical average	Mm MN nnnn	OK
Measurement interval number at arithmetical average	Measurement interval number at moving average Number of scans for averaging at moving average	MS m MNH nnnn	OK
Storage of measuring conditions		STR	OK
Key lock		LOCK	OK
Releasing key lock		UNLOCK	OK
Setting the SHL for transparent object measurement *1		SHL pp	OK
Request of measuring conditions list		RP	(RP FORMAT)
Setting the measuring conditions		SET	OK
(Segment specification Edge specification) *2		,SG sssssss ,SG aaa-bbb	
(Measurement interval number at arithmetical average Number of scans for averaging at arithmetical average Measurement interval number at moving average Number of scans for averaging at moving average)		,Mm ,MN nnnn ,MS m ,MNH nnnn	
(Lower abnormal limit Upper abnormal limit) *2		,EL±ddd.dddd ,EH±ddd.dddd	
(Lower limit Upper limit Multi-stage selection value Target value Lower tolerance limit Upper tolerance limit) *2		,LL±ddd.dddd ,LH±ddd.dddd ,L1±ddd.dddd, · · · ·, ,L6±ddd.dddd ,N±ddd.dddd ,LO±ddd.dddd ,UP±ddd.dddd	
Reference value *3		,REF±ddd.dddd	
(Positive offset Negative offset Positive zero-set Negative zero-set)		,OF±ddd.dddd ,OM±ddd.dddd ,ZERO+ ,ZERO–	

Item		Reception command	Response command
Data output conditions		,PR r	OK
Periodic data output conditions Periodic output timer		,PRT ttt	
Number of sample measurements		,SMP nnn	
Setting the statistical item for sample measurement (Maximum value, minimum value, range, mean)		,(MAX,MIN,RNG,AVG)	
Group sizes subject to judgment *2 Lower tolerance limit for group judgment Upper tolerance limit for group judgment Statistical item for group judgment (Maximum value, minimum value, mean, range)		,GN nn ,GLL±ddd.dddd ,GLH±ddd.dddd ,(GMX,GMN,GAG,GRG)	
Start of single-run measurement		R	(DATA FORMAT)
Continuous-run measurement	Measurement start command	CR	(DATA FORMAT) *4
	Measurement stop command	CL	OK
Zero-run measurement	Measurement start command	R	No response command
	Measurement stop command	STOP	(DATA FORMAT)
Request of measurement data		D	(DATA FORMAT)
Statistical processing calculation	Performs statistical processing	ST	OK
	Does not perform statistical processing	NST	OK
Erasing the statistical processing memory	Current program only	MC	OK
	All programs	MCAL	
Request of statistical processing results		STAT	(STAT FORMAT)
Condition setting of automatic workpiece detection *2 • Number of measurement times • Invalidation period • Lower detection limit • Upper detection limit		AUT ,N mmm ,D tttt ,L±ddd.dddd ,H±ddd.dddd	OK
Automatic workpiece detection control *2		AUT, S	OK
Request of conditions list for automatic workpiece detection *2		RA	(RA FORMAT)

*1: • Do not use the SHL command unnecessarily unless there is a need to change the threshold voltage because of the workpiece property, since it adversely affects the measuring accuracy.
• In order to restore the standard threshold voltage, enter the following command:
"SHL50" Resets to 50%, which is the standard.
"STR" Records the value in memory.
• The SHL command will be effective if the transparent measurement is selected in the basic setup mode.
*2: Designating any command of the functions which are set to "Not used" in the basic setup will result in ER6.
*3: If "Copying the target value to the reference value" is specified in the basic setup, designating this command results in ER-6.
*4: Responds with measurements according to the data output conditions.

6.1.6 List of response commands if an error occurs

Response command	Description
ER0	A workpiece is not present in the specified segment. • A workpiece is not set properly. • Shutter is closed.
ER1	All setup data are initialized (cleared) when the power is ON.
ER2	A numeric value greatly different from the reference gage dimension is set.
ER5	• Limit values for go/no-go judgment and abnormal data exclusion have been set in reverse order or equal. • Input value is too large.
ER6	An unavailable command is received. • Command format is incorrect. • Baud rate and/or data bits are not consistent.
ER7	Message from the external device • Measurement is interrupted by signal input from key operation.
ER9	Parity error occurred. • Check the setup contents in the basic setup. • Isolate the cables from noise sources.

6.1.7 Format of response commands

1) (DATA FORMAT): Data format (maximum 38 characters)

Pp, (GO/NG judgment result) ±ddd.dddd (, deviation)

a. Where the GO/NG judgment is active, GO/NG judgment result (-NG, OK or +NG) will be appended.
b. Where the reference value is set, a deviation (, DEV±ddd.dddd) is appended. This deviation value is derived from (Measured data - Reference value).
c. In the simultaneous measurement the foreground measurement is followed by the background measurement after a comma (,) is inserted between them.

2) (RP FORMAT): Report format (maximum 107 characters)
PROGRAM, Pp, SG sssssss, Mm, LL ±ddd.dddd, LH ±ddd.dddd, REF ±ddd.dddd, OF ±ddd.dddd, PR r, PRTttt, SMPnnn, AVG, ST

- A maximum of 107 characters will result from the above described specification, however, it varies depending on the setup.
  a. A maximum of 5 characters are to be added if the number of averages is specified.
  b. A maximum of 8 characters are to be added if (target value + tolerance) is specified.
  c. A maximum of 52 characters are to be added if the multi-stage selection is specified.
  d. A maximum of 32 characters are to be added if the abnormal value eliminating function is specified.
  Between MM and LL "EL ±ddd.dddd, EH ±ddd.dddd" is inserted.

- Available symbols may change depending on the setup contents.
  a. SG sssssss → SG aaa-bbb
  b. Mm → Mnnnnn, Msm or MNHnnnn
  c. LL ~ LH ±ddd.dddd → N ±ddd.dddd, LO ±ddd.dddd, UP ±ddd.dddd
  → L1 ±ddd.dddd, ... , L6 ±ddd.dddd
  e. OF ±ddd.dddd → OM ±ddd.dddd
  f. AVG → MAX, MIN or RNG
  g. ST → NST

3) (STAT FORMAT): Statistical data format (maximum 86 characters)
STAT DATA, Pp, Nnnnnnn, AVG±ddd.dddd, MAX±ddd.dddd, MIN±ddd.dddd, RNGddd.dddd,S.Dddd.dddd

- "nnnnnn" implies the number of statistical data pieces, which is maximum 100,000. Data pieces that exceed this limit will be excluded from the statistical data.

4) (RA FORMAT) : Data format for automatic workpiece detection (maximum 36 characters)
AUT, Nmmm, Dtttt, L±ddd.dddd, H±ddd.dddd

TIP
1. The integer section of "±ddd.dddd" will be zero-suppressed.
2. The "±" section will be "-" if the value is negative, and will be removed (the following digits are left-flushed) if the value is positive.

6.1.8 Other commands

1) Each of the D, R, and CR commands can be appended with an “N”.
If appended with an “N”, each program number will be removed from these commands.

Item	Reception command
Data request	DN
Single-run measurement (zero-run measurement)	RN
Continuous-run measurement	CRN

Example: “D” → “P0, 12.3456” : Appended with a program number
“DN” → “12.3456” : Program number is removed.

2) Each of the D, R, CR, RP, STAT, and RA commands can be appended with an “*”.
If appended with an “*”, these commands have a fixed data length that is not zero-suppressed.

Item	Reception command
Data request	*D *DN
Single-run measurement (zero-run measurement)	*R *RN
Continuous-run measurement	*CR *CRN
Request of measuring conditions list	*RP
Request of statistical processing results	*STAT
Request of automatic workpiece detection conditions list	*RA

Example: “D” → “P0, 12.3456” : Zero suppressed.
“*D” → “P0, +012.3456” : Outputted in 7 digits without zero suppressing.

6.1.9 Details of command descriptions

(1) CL

(a) Format: CL
(b) Description: Functions same as the [C] key on the Display Unit.
This releases the error state, performs single-run measurement, zero-run measurement, continuous-run measurement, and releases the measurement result display latch.
(c) Example: Reception command CL
Transmission command OK

(2) MM, E

(a) Format: MM
E
(b) Description: MM: Sets the display unit to mm.
E: Sets the display unit to E (inch).
(c) Example: Reception command MM or E
Transmission command OK

(3) P

(a) Format: Pp (p: program number)
(b) Description: Program number is changed to the specified one.
(c) Example: Reception command P5
Transmission command OK

(4) HC, LC

(a) Format: HC+ddd.dddd
LC+ddd.dddd
(b) Description: Calibrates the LSM.
If the supplied gage is set in position and this command is executed, the proportion of the actually measured gage dimension to the entered value is calculated and the resultant constant is stored in memory, then the “OK” response will be issued. It requires approximately a second.
(c) Example: Reception command HC24.0005 Transmission command OK
Reception command LC 0.9995 Transmission command OK
(d) Supplement: Negative setup data results in ER2

(5) SG sssssss, SG aaa-bbb

(a) Format: SG sssssss (sssssss: SEG No. Number of digits should be between 1 and 7. Duplicated number must not be specified.)
SG aaa-bbb (aaa: start edge, bbb: finish edge. The range is between 1 and 255 for both edges. However, aaa should not be identical to bbb.)

(b) Description: Setting the segment (measuring position).
Two types of setting are available; segment specification and edge specification.

(c) Example: Reception command SG2 Response command OK
Reception command SG2-65 Response command OK

(d) Supplement:
- Segments and edges should be set in the basic setup.
- sssssss can be set with 7 digits or less.
  Ex.) SG 1234567, SG 24, SG3, etc.
- aaa and bbb should be set within 3 digits.
  Ex.) SG1-2, SG 2-33, SG 111-255, etc.
  The order of the start edge and finish edge can be reversed.

(6) M

(a) Format: M m (m: measurement interval number, 1 to 4)

(b) Description: Set the averaging method to the arithmetical average, and set a number between 1 and 4 for the representative measurement interval numbers. With these measurement interval numbers compatibility with the conventional models is ensured.

(c) Example: Reception command M4
Response command OK

(d) Supplement: Relationship between the measurement interval number, measurement interval, and number of scans for averaging is as follows:

Measurement interval number	Measurement interval	Number of scans for averaging
1	0.01 sec	16 times
2	0.04 sec	64 times
3	0.16 sec	256 times
4	0.32 sec	512 times

(7) MN

(a) Format: MN nnnn (nnnn: Number of scans, between 1 and 2048)

(b) Description: Set the averaging method to the arithmetical average, and specify the number of scans to nnnn (2^n, where n= 0 to 11).

(c) Example: Reception command MN 1024
Response command OK

(8) MS

(a) Format: MS m (m: Measurement interval number, between 2 and 4)

(b) Description: Set the averaging method to the moving average, and specify a measurement interval number to ensure compatibility with conventional models.

(c) Example: Reception command MS4
Response command OK

(d) Supplement: Relationship between the measurement interval number, measurement interval, and number of scans for averaging is as follows:

Measurement interval number	1st measurement interval	2nd measurement interval	Number of scans for averaging
2	0.04 sec	0.01 sec	64 times
3	0.16 sec	0.01 sec	256 times
4	0.32 sec	0.01 sec	512 times

(9) MNH

(a) Format: MNH nnnn(nnnn: Number of scans, between 32 and 2048)
(b) Description: Set the averaging method to the moving average, and specify the number of scans with nnnn. nnnn is 2^n, where n= 5 to 11.
(c) Example: Reception command MNH 1024
Response command OK
(d) Supplement: MNL command is as same as MNH command

(10) STR

(a) Format: STR
(b) Description: Data that has been set by the RS-232C command will be erased from memory if the power is off. To retain the data after the power off, use this command to save the critical measuring conditions in memory. But the “ST” and “NST” command will not be saved.
(c) Example: Reception command STR
Response command OK

(11) LOCK

(a) Format: LOCK
(b) Description: Locks the keyboard of this machine to prevent accidental operation.
To release this key lock state, use the UNLOCK command.
(c) Example: Reception command LOCK
Response command OK
(d) Supplement: Lock set by this command can not be released with key operation.

(12) UNLOCK

(a) Format: UNLOCK
(b) Description: Releases the key lock state and enables key operations again.
(c) Example: Reception command UNLOCK
Response command OK

(13) SHL

(a) Format: SHL pp (pp: threshold level, 50 to 90%)
(b) Description: If “Performing the ultra-fine wire measurement” is specified in the basic setup, designating this command results in ER6.
Used to measure such as the width of a tape, which has a good transparency.
(c) Example: Reception command SHL
Response command OK
(d) Supplement: Refer to Section 3.2.4.1, “Transparent object (Workpiece that transmits light)”.

(14) RP (RP FORMAT)

(a) Format: RP

(b) Description: This is used to confirm the setup contents, if the measuring conditions and operating conditions set are received as the response.

(c) Example:
Reception command RP command
Response command PROGRAM, SG 2, M3, LL D 5.988, LH 6.010, REF6.000, OF 0, PR 3, PRT0, SMP20, MAX, ST

(15) SET

(a) Format: SET

Segment specification *1	, SG sssssss
Edge specification *1	, SG aaa-bbb
Measurement interval number at arithmetical average	, M m
Number of scans for arithmetical average	, MN nnnn
Measurement interval number at moving average	, MS m
Number of scans for moving average	, MNH nnnn
Lower abnormal limit *2	, EL±ddd.dddd
Upper abnormal limit *2	, EH±ddd.dddd
Lower limit *1	, LL±ddd.dddd
Upper limit *1	, LH±ddd.dddd
Multi-limit selection value *1	, L1±ddd.dddd , L2 • • • • , L6±ddd.dddd
Target value *1	, N±ddd.dddd
Lower tolerance limit *1	, LO±ddd.dddd
Upper tolerance limit *1	, UP±ddd.dddd
Reference value *3	, REF±ddd.dddd
Positive offset *4	, OF±ddd.dddd
Negative offset *4	, OM±ddd.dddd
Positive zero-set *4	, ZERO+
Negative zero-set *4	, ZERO–
Data output condition *5	, PRr
Periodic data output timer	, PRT ttt
Number of sample measurements	, SMP nnn
Sample measurement • Maximum value *6	, MAX
• Minimum value *6	, MIN
• Range *6	, RNG
• Mean *6	, AVG
Group size subject to judgment *2	, GN nn
Lower tolerance limit of group judgment *2	, GLL±ddd.dddd
Upper tolerance limit of group judgment *2	, GLH±ddd.dddd
Statistical items for group judgment: Maximum value *2, 6	, GMX
: Minimum value *2, 6	, GMN
: Mean *2, 6	, GAG
: Range *2, 6	, GRG

(b) Description: This sets the measuring conditions.
- Each of the commands that follow the SET command must be delimited by a comma (,).
- A command which doesn't need a setting change can be eliminated.
- Approximately 0.5 second is required for this command to be processed.

(c) Example: Reception command SET, SG2, M4, LL 5.988, LH 6.010, REF6.000, OM 0, PR 3, PRT10

*1: Select either setup method in the basic setup.

*2: This is valid only if the function is specified in the basic setup.

*3: This is valid only if the "Copying the target value to the reference value" is specified in the basic setup.

*4: Set the reference gage on the Measuring Unit before sending this command. These commands will spend approximately 1 second for processing. The settings of each function are as follows:
- Positive offset: Offsetting in the positive (0) direction.
- Negative offset: Offsetting in the negative (1) direction.
- Positive zero-set: Zero-setting in the positive (0) direction.
- Negative zero-set: Zero-setting in the positive (0) direction.

*5: "PRr" is used to set the data output conditions for the RS-232C (printer) or Digimatic Output Unit interface. If the PR number is 1, 3 or 5, it is possible to set the periodic output timer, and the data output interval can be selected from 0 (for each measurement) and between 1 and 999 seconds.
The PR numbers and the data output conditions have the following relationships.

Data output condition (PR No.)	RS-232C DCU	Printer	Remark
0	—	—	
1	—	○	The periodical output timer can be set
2	—	△	
3	○	—	The periodical output timer can be set
4	△	—	
5	○	○	The periodical output timer can be set
6	△	△	
7	—	□	
8	□	—	
9	□	□	

○ : Outputs data for each measurement.
△ : Performs measurement and outputs data when a GO measurement results.
□ : Performs measurement and outputs data when a ±NG measurement results.
— : No output

*6: Only one of these statistical items can be specified.

(16) R

(a) Format: R

(b) Description: If the number of samples is set between 1 and 999, this command executes single-run measurement and transmits the measurement result in conformity with DATA FORMAT as the response command.

(c) Example:

Reception command	R
Response command	P0, 12.3456

(17) CR, CL

(a) Format: CR
CL

(b) Description: CR: If the number of samples is set between 1 and 999, this command executes continuous-run measurement. However, it does not respond to the "CR" command.

- It transmits the measured results in conformity with DATA FORMAT for the response command.

CL: Terminates continuous-run measurement.

(c) Example:

Reception command	Response command
CR	None

- Outputs as the response, the measurement results according to the data output conditions in conformity with DATA FORMAT.

CL	OK

(18) R, STOP

(a) Format: R
STOP

(b) Description: R: If the number of samples is set to 0, this command executes zero-run measurement. However, it does not respond to "R" command.

STOP: Terminates the zero-run measurement, and transmits the measurement results in conformity with DATA FORMAT as the response.

(c) Example:

Reception command	R
	STOP
Response command	P0, 12.3456

(19) D

(a) Format: D

(b) Description: Transmits as the response the last display of data in the ready state or latched data not in conformity with DATA FORMAT.
This command is used to transmit the previous data, while the R command is used to execute measurement then the results are transmitted.

(c) Example:

Reception command	D
Response command	(DATA FORMAT)

(20) ST, NST

(a) Format: ST
NST

(b) Description: ST : Performs statistical processing. However, measurements obtained in the ready state will be omitted from the objectives of statistical processing.
NST: Terminates the statistical processing.

(c) Example:
Reception command ST or NST
Response command OK

(21) MC, MCAL

(a) Format: MC
MCAL

(b) Description: Both the MC and MCAL commands are used to clear the statistical memory. This operation is required before starting statistical processing.

(c) Example:
Reception command MC or MCAL
Response command OK

(22) STAT

(a) Format: STAT

(b) Description: Requests the statistical processing data. The statistical processing data will be cleared when the power is off.

(c) Example:
Reception command STAT
Response command STAT DATA, N100, AVG12.0001, MAX12.0005, MIN11.9998, RNG0.0007, S.D0.00007

(23) AUT

(a) Format: AUT, Nmmm, Dtttt, L±ddd.dddd, H±ddd.dddd

(b) Description: Set the conditions of automatic workpiece detection with the following data to follow "AUT" and delimited by a comma (,).
Lower and upper detection limits for the position detection method do not require a "-" sign, so it will be ignored if specified.

- Responds only when the automatic workpiece detection has been set in the basic setup.
- N mmm (mmm: number of measurement times between 1 and 999. If "0" is specified, automatic workpiece detection is not performed.)
- Dtttt (tttt: Invalidation period between 0 and 9999 ms)
- L±ddd.dddd (±ddd.dddd: Lower detection limit)
- H±ddd.dddd (±ddd.dddd: Upper detection limit)

(c) Example:
Reception command AUT, N50, D15, L9.5, H12.3
Response command OK

(24) AUT, S

(a) Format: AUT, S
(b) Description: Where “Performing the automatic workpiece detection” is specified in the basic setup, and if this command is received, “S” will be responded each time a workpiece is detected.
If this setup is not made in the basic setup, designating this command results in ER6.
(c) Example: Reception command AUT, S
Response command OK

(25) RA

(a) Format: RA
(b) Description: Transmits as the response the conditions of the automatic workpiece detection using RA FORMAT.
(c) Example: Reception command RA
Response command AUT, N50, D15, L9.5, H12.3

(26) Timing signal

If the measuring operation is interrupted by a command from the key operation, an ER7 will be responded to the RS-232C interface.

6.1.10 An example Program of RS-232C Communication

The following is an example BASIC program for the PC-9801 (NEC) computer.

```
90 CLS 3
100 PRINT "-------------------------------------------------------"
110 PRINT " Set the next                                          "
120 PRINT " 1:SPEED, 2:LENGTH, 3:PARITY, 4:FLOW CONTROL           "
130 PRINT " (9.6KBPS)  (8BIT)   (NONE)      (NONE)                "
140 PRINT "-------------------------------------------------------"
150 INPUT "<CR>---OK START",A$
160 '                                                  } Setup for the RS-232C
170 OPEN "COM:N81N" A$ #1                              } communication
180 '
190 A$="CL"                                            }
200 PRINT "RS OUT=";A$                                 }
210 PRINT #1,A$                                        } Repeat the “CL” command
220 '                                                  } transmission until “OK” is received.
230 LINE INPUT #1,B$                                   }
240 PRINT "RS INP=",B$                                 }
250 IF B$="OK" THEN ELSE 190                           }
260 '
270 A$="SET,SG2,M3,LL0,LH0,REF0,SMP1"                  }
280 PRINT "RS OUT=";A$                                 } Set the measuring conditions.
290 PRINT #1,A$                                        }
300 '                                                  }
310 FOR T=1 TO 500                  : '0.5sec timer    }
320 NEXT T                                             }
330 '                                                  }
340 LINE INPUT #1,B$                                   }
350 PRINT "RS INP=",B$                                 } Acknowledge the “OK” response.
360 IF B$="OK" THEN ELSE 190                           }
370 '
380 A$="RN"                                            } Transmission of “RN” command
390 PRINT "RS OUT=";A$                                 } (Single-run measurement)
400 PRINT #1,A$                                        }
410 '                                                  } Wait until measurement is
420 FOR T=1 TO 1000                 : '1sec timer      } completed.
430 NEXT T                                             }
440 '
450 LINE INPUT #1,C$                                   } Digitize the measurement
460 C=VAL(C$)                                          } result response and display it
470 PRINT "RS INP=";C$;             " DATA=";C         } on the CRT.
480
490 END
```

TIP
1. Each command should be of the programming language to be used.
2. Depending on the timing gap between the host machine and the LSM, meaningless data may be transmitted/received. Therefore, always send the “CL” command and acknowledge the “OK” command before starting the communication.
3. Timer settings should be compatible to the processing time required for each command and the host machine.

6.2 Digimatic Output Unit interface

With the Digimatic Output Unit interface the LSM can be connected to the Digimatic Data Processor (DP-1HS, etc.) which uses the Mitutoyo-original data format for easy data collection and processing.

6.2.1 Method of use

1) In the B6 mode of the basic setup, make the settings for the Digimatic Output Unit interface.

USE : The Digimatic Output Unit interface is valid.

- Set the data output conditions in the function setup.

Data output condition	RS-232C DCU	Printer	Remark
0	—	—	
1	—	○	The periodical output timer can be set
2	—	△	
3	○	—	The periodical output timer can be set
4	△	—	
5	○	○	The periodical output timer can be set
6	△	△	
7	—	□	
8	□	—	
9	□	□	

○ : Outputs data for each measurement.
△ : Performs measurement and outputs data when a GO measurement results.
□ : Performs measurement and outputs data when a ±NG measurement results.
— : No output

2) Data output

a. When a data send request comes from the external equipment such as the Digimatic Data Processor to the LSM, the measurement data will be outputted through this interface by the following timing.

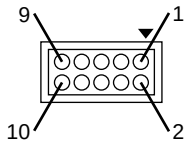
- When the [DATA] key on the Digimatic Data Processor is pressed
- When the foot switch being connected to the Digimatic Data Processor is pressed.
- When an $\overline{\text{REQ}}$ signal is inputted from other external equipment.

b. When the measurement is initiated by pressing the [RUN] key or “R” command from the RS-232C interface, the measurement data will be outputted according to the data output conditions being set.

6.2.2 I/O specifications

The following are the I/O specifications of the Digimatic code output interface.

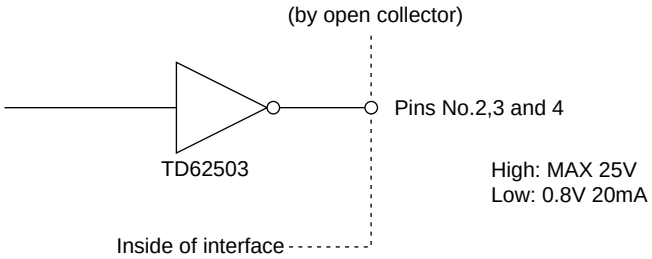
- Applicable connector: 7910-B500 (Manufacturer: 3M)
  XG4M-1030 (Manufacturer: Omron)



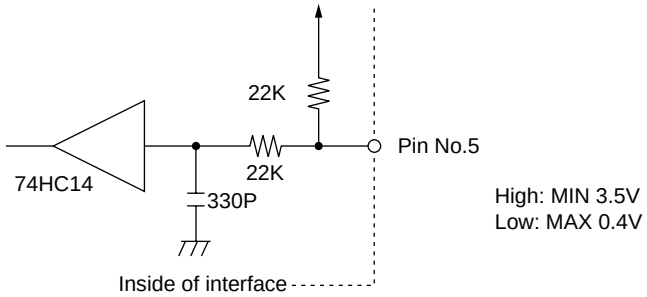
- Pin assignment

Pin No.	Signal name	I/O direction	Function
1	GND	—	Signal GND
2	DATA	Out	Data out
3	$\overline{\text{CK}}$	Out	Data transmission clock
4	$\overline{\text{RDY}}$	Out	Data read request for external device
5	$\overline{\text{REQ}}$	In	Data output request from external device
6~9	I.C	—	Spare
10	F.G	—	Frame GND

- Signal output circuit

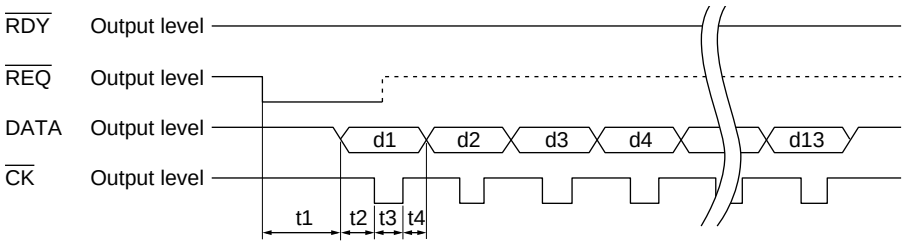


- Signal input circuitry



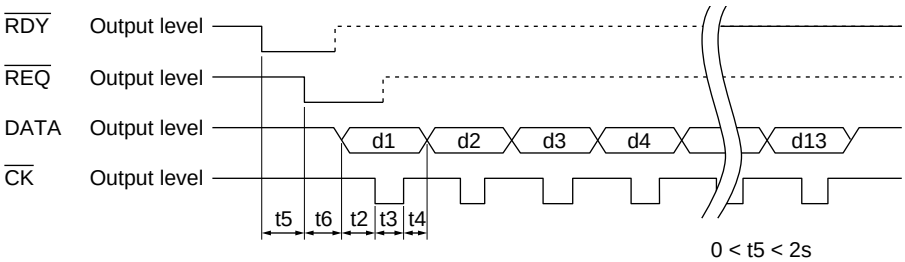
6.2.3 Timing chart

1) When a data request is transmitted from a Digimatic data processor to the LSM



t1:10 ms or less (measurement time if successively requested)
t2: 0.2 to 1 ms
t3: 0.2 to 1 ms
t4: 0.2 to 1 ms

2) When a data read request is transmitted from the LSM to the Digimatic data processor



0 < t5 < 2s
t6: 0 to 100 ms
t2: 0.2 to 1 ms
t3: 0.2 to 1 ms
t4: 0.2 to 1 ms

TIP
- The DP-series Digimatic Data Processor takes approximately 2 seconds for processing each data. Therefore, do not issue a data output request at an interval less than 2 seconds.
- Data will not be outputted while an error message is shown on the LSM display.
- If the Digimatic Data Processor shows an error message, check the number of digits (of the sent data) below decimal point. For detail refer to Section 6.2.4, “Data format”.

6.2.4 Data format

Digimatic data format consists of measured data which is made up of 13 hexadecimal digits using 0 to F, each 4 bits (of binary data) long. The data is output serially, starting from the LSB (Least Significant Bit) of the LSD (Least Significant Digit) to the MSB (Most Significant Bit) of the MSD (Most Significant Digit). The 13 digits have the following content.

Digit	Function	Bit configuration
d1 d2 d3 d4	Unassigned	F (1111) F (1111) F (1111) F (1111)
d5	Sign	+ : 0 (0000) – : 8 (1000)
d6 d7 d8 d9 d10 d11	Measured data (6 digits of BCD)	MSD LSD
d12	Decimal point position	X 10 $^{-0}$: 0 (0000) X 10 $^{-1}$: 1 (0001) X 10 $^{-2}$: 2 (0010) X 10 $^{-3}$: 3 (0011) X 10 $^{-4}$: 4 (0100) X 10 $^{-5}$: 5 (0101)
d13	Unit (Go/±NG judgment results)	mm : 0 (0000) inch : 1 (0001) mm (+NG) : 2 (0010) mm (GO) : 3 (0011) mm (-NG) : 4 (0100) inch (+NG) : 5 (0101) inch (GO) : 6 (0110) inch (-NG) : 7 (0111)

An example of output data

d1	d2	d3	d4	d5	d6	d7	d8	d9	d10	d11	d12	d13
F	F	F	F	0	2	1	0	7	6	5	4	0

d5 d6~d11 d12 d13

+ 210765 x 10^{-4} mm

→ +21.0765mm

NOTE 1. Decimal Point Position

The decimal point position will be adjusted as follows for the DP series data processor, which handles 6-digit data.

- If the uppermost (7th) digit of the output data is 0, the lower six digits will be output.
- If the uppermost (7th) digit of the output data is not 0, the upper six digits will be output.
- If six digits are in the decimal places, a “0” is output as a decimal point position.

Example)

Display	Digimatic code output	
	Transmitted data	Decimal point position
5.4321	054321	4
65.4321	654321	4
765.4321	765432	3
0.654321	654321	0
7.654321	765432	5

- When the decimal point position of the input data is changed, the DP series data processor cannot continue the data processing unless the accumulated data is cleared. (Therefore, consider the measuring range of the LSM so that the resulting data has a uniform decimal point position.)

2. The data of the foreground program is outputted in simultaneous measurement.

7 INSPECTION AND MAINTENANCE

This chapter describes the method of maintenance and troubleshooting, as well as the contents of the error messages and remedies.

7.1 Display Unit

The Display Unit will, if it is turned on, perform a self-check.

7.1.1 Display check

- If the power is on, display check mode is entered.
  All LEDs and display sections turn on and then turn off. Then digit 8 turns on successively [888···8] from the upper display section: during which check the display elements if they are normal and uniform in intensity.
- Internal circuit checking is carried out and if found to be normal, LASER EMISSION LED turns on. Then the BUSY LED starts blinking and measurement will start from the ready state.
- Error message will be displayed if abnormality is detected during selfcheck of the internal circuit. For details of error message, refer to 7.3, “Error Messages and Remedies”.

7.1.2 Cleaning method

If the Display unit is contaminated, unplug the power cord from the inlet first, then wipe lightly with a soft dry cloth for the operator's safety.

7.2 Measuring Unit

This section describes the method of maintenance and inspection of the Measuring Unit.

7.2.1 Cleaning optical parts

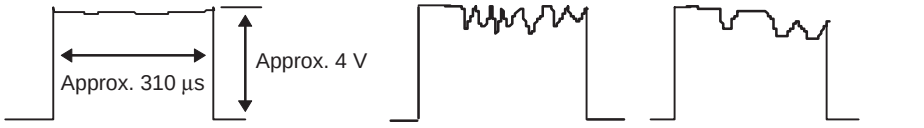
Periodically clean the protection glass of the emission window and reception window. If these protection glass is contaminated, not only is the measuring accuracy reduced but the display unit mistakes the dimension of dust or foreign matter with that of the measuring object.

7.2.1.1 Checking method of the reception signal using an oscilloscope

There is the “SCAN SIG”, the test terminal for the reception signal, on the rear panel of the main unit. Check the “SCAN SIG” test terminal with an oscilloscope probe.

The setting of an oscilloscope is as shown below.

- Vertical sensitivity: 0.1V/DIV (when using a 10-times probe(x10))
- Horizontal sensitivity: 50 µs/DIV



(a) normal waveform (b) waveform when the protection glass is contaminated

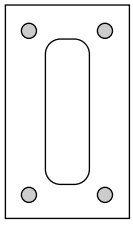
Clean the protection glass according to the following procedure, if the oscilloscope waveform(b) was observed.

For cleaning, use either a blower or wipe lightly with gauze dampened with a small amount of ethyl alcohol.

IMPORTANT Clean windows are vital for precision measurement in the LSM system. Handle the glass with care.

7.2.2 Replacement of protection glass

For temporarily removing the protection glass for replacement or cleaning since it is damaged or contaminated, use the following procedure.

Disassembly procedure	Unscrew the 4 to 6 screws that secure the protection glass. 
Reassembly procedure	Follow the above procedure in reverse.
Precautions	If the protective glass is removed, dust may enter inside of the unit. If the ambient air contains moisture, the glass may dim. Perform disassembly/reassembly in a room which is free from dust and well-ventilated.

7.3 Error Messages and Remedies

The table below lists the error messages and their remedies.

Display	Meaning	Remedies
Err-0	Segment error • There is no measuring object that corresponds to the specified segment. • The shutter has been closed. • Laser characteristic may be deteriorated.	• Check if a workpiece is present. • Check the segment settings. • Open the shutter. • Check the LASER EMISSION LED.
Err-1	Setup item error • There is a certain conflict in the setup data.	• Press the C key to clear the error message. • Previously setup contents are lost. Redo setup from the beginning.
Err-2	Calibration error • Incorrect segment setting • A value significantly different from the dimension of the reference gage is entered. • The HIGH CAL setting value is too close to the LOW CAL setting value.	• Press the C key to clear the error message. • Redo the segment setting again. • Cancel the setting value, then set it again. For information about the cancellation procedure, refer to Section 4.2, "Calibration".
Err-5	Setup value error: • The upper limit value is set lower than the lower limit value, or HIGH CAL ≤ LOW CAL. • Input the unacceptable value.	• Clear the error message by pressing the C key. • Clear the wrong setup values and re-enter the correct values.
ERR-88 Err-8	Laser does not scan. • Short-circuiting pin is not inserted in the remote interlock connector. • Laser diode is deteriorated. • Scanner motor is not running.	• Insert the short-circuiting pin. • Contact the nearest dealer or Mitutoyo sales representative.
LASER EMISSION ▬	Laser diode anomaly (LASER EMISSION LED is blinking.) • The laser diode is forced to operate below a temperature outside the specified range. • Laser diode begins to deteriorate.	• Using the laser diode at a high temperature reduces efficiency and accelerates deterioration in addition to drawing a large current. Take appropriate measures to cool the diode. • Contact the nearest dealer or Mitutoyo sales representative.
EEEEEEEEEEE	Internal circuit error.	Contact the nearest dealer or Mitutoyo sales representative.
Prt Err	Printer error • Cable is not connected or broken. • Communication conditions are not consistent.	• Check the cable connection.
dCU Err	Setup value error: • Cable is not connected or broken.	• Check the cable connection. When the printer is not used, set to NONE in the basic setup.

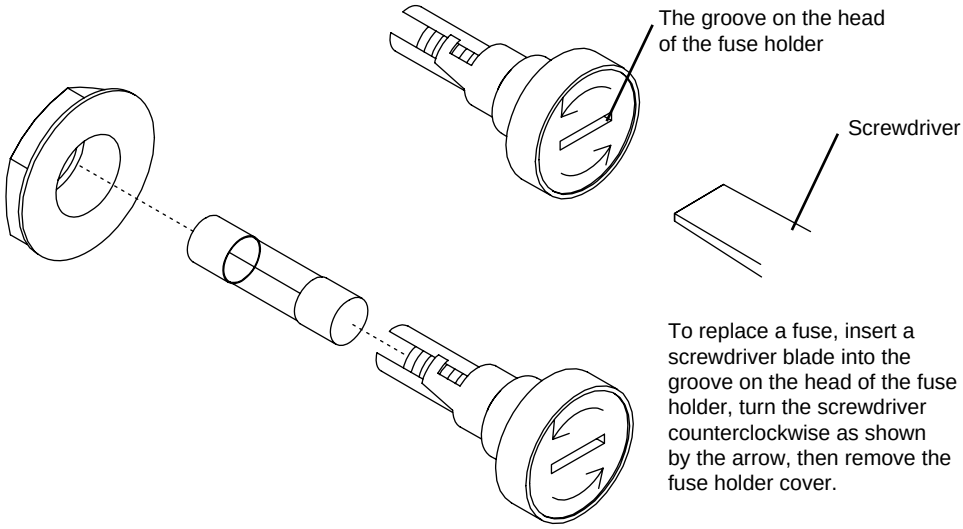
7.4 Troubleshooting and Remedies

The following table shows the troubleshooting and remedies on the LSM system.

Symptoms	Possible causes	Remedies
The LSM does not start if the power is turned on.	• The power cord is not connected. AC power supply is off or failed. • The fuse is blown out.	• Check the power cord and AC power supply. • Replace a fuse after fixing the cause of blowout.
Measurements are unstable, resulting in a poor accuracy.	• Warm-up of the system is insufficient. • Measuring Unit is directly subjected to sunlight or air flow from the air conditioner. • Contaminated protection glass. • Vibration of workpiece. • Laser diode power is reduced.	• Warm up the system at least 20 to 30 minutes. • Take measures to avoid the system from being subjected those troubles. • Clean the glass by referring to Section 7.2, “Measuring Unit” • Set a larger number of scans. • Check the LASER EMISSION LED is blinking. If it does, contact Mitutoyo or the nearest sales representative.
Measuring error persists even after calibration	• Contaminated protection glass.	• Clean the glass by referring to Section 7.2, “Measuring Unit”
Statistical processing can not be achieved.	• Single-run measurement, continuous-run measurement, or zero-run measurement has not been performed. • “ST” command is not sent through RS-232C.	• Perform the single-run measurement, continuous-run measurement, or zero-run measurement. • Send the “ST” command.
The system incorrectly operates.	• The system is electrically interfered.	• Make a positive grounding. • The external power supply should be drawn from a line with little electrical interference.
Measurement does not terminate while [- - - - - - - -] is displayed.	• The number of samples in the sample measurement it too large. • Under the use of abnormal value eliminating function the workpiece dimension is significantly different from the setup value.	• Stop the measurement with the [C] key and set a smaller number of samples. • Check the setup value
Measurement interval does not match the measuring conditions.	• Under the use of the abnormal value eliminating function the workpiece dimension is significantly different from the setup value.	• Check the setup value.

7.5 Fuse replacement

- Before replacing a fuse, turn the power switch to OFF and unplug the power cord from the inlet for safety.
- Always use fuses that have the specified rating.
- Refer to the following diagram for the replacement procedure.



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8 SPECIFICATIONS

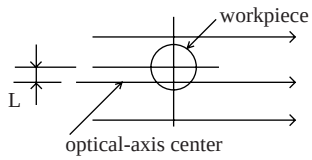
This chapter describes the specifications, supplied accessories and external view and dimensions of the LSM-9506.

8.1 Specifications

(1) Specifications

Code No.	544-116-1A (mm/inch)	
Model No.	LSM-9506	
Measuring range	0.5 to 60 mm (.02 to 2.36″)	
Resolution	0.05 to 100 µm (.000002 to .005″)	
Repeatability *1	± 0.6 µm (± .00003″)	
Linearity *2	± 2.5 µm (± .0001″)	
Positional error *3	± 2.5 µm (± .0001″)	
Positional error *4	± (2.0 + L/10) L : The gap between the workpiece center and optical-axis center. (mm) (± .00008 + L/10000)″ [L : inch]	
Measuring region *5	± 5 x 60 mm (± .2 x 2.36″)	
Scanning rate	1600 scans/sec	
Laser wavelength	650 nm (Visible)	
Laser scanning speed	226 m/sec	
Display unit	16-digit dot-matrix type display (upper) + 11-digit 7-segment display (lower) and 7 guidance LEDs.	
Measuring functions	Segment specification: 1 to 7 (1 to 3 for transparent objects) Edge specification : 1 to 255 edges	
	Averaging method	Arithmetical average 1 to 2048 times
		Moving average 32 to 2048 times
	Tolerance judgment (±NG, GO), Multi-stage selection (7 stages), Offset/zero-set, Mastering, Group judgment, Abnormal value elimination, Automatic workpiece detection, Setting the reference data, Data output, Sample measurement, Statistical processing , Simultaneous measurement, Automatic measurement with edge specification, Transparent object measurement (Segment: 1 to 3), Workpiece position display, Key entry prohibition, mm ↔ E changeover, Dual-gage calibration, Setting the resolution, Display of comma (“,”) to mark the thousandth digit, Setting the number of blank-out digits, Setting the GO/NG judgment method, GO/NG judgment, Laser power deterioration monitoring. Remark: There are some restrictions on the combination of the above functions.	
Scanning control signal connector	Standard accessory	
Remote interlock connector	Standard accessory	
Power switch	Key switch	
Standard interface unit	RS-232C, Footswitch, Digimatic output unit interface	
Rated power supply	100 ~ 240 VAC, ±10%, 50/60 Hz, 40 VA	
Operating environment	0 to 40°C, 35 to 85% RH (without condensation)	
Operating altitude	2000 m or lower	
Storage environment	-15 to +65°C, 20 to 90% RH (without condensation)	
Protection class	IP50	
Mass	Approx. 13 kg	
Safety	Compliance with EN61010-1 (OVER VOLTAGE CATEGORY II, POLLUTION DEGREE 2)	

*1: Value indicates repeatability (± 2σ) of ø60 mm range measurement at measuring interval of 0.32 sec. (average of 512 scans)
*2: Guaranteed when measured at the center of the measuring range in the ambient temperature of 20°C.
*3: optical-axis direction
*4: scanning direction
*5: Optical-axis direction x scanning direction (measuring range)



(2) Standard Accessories

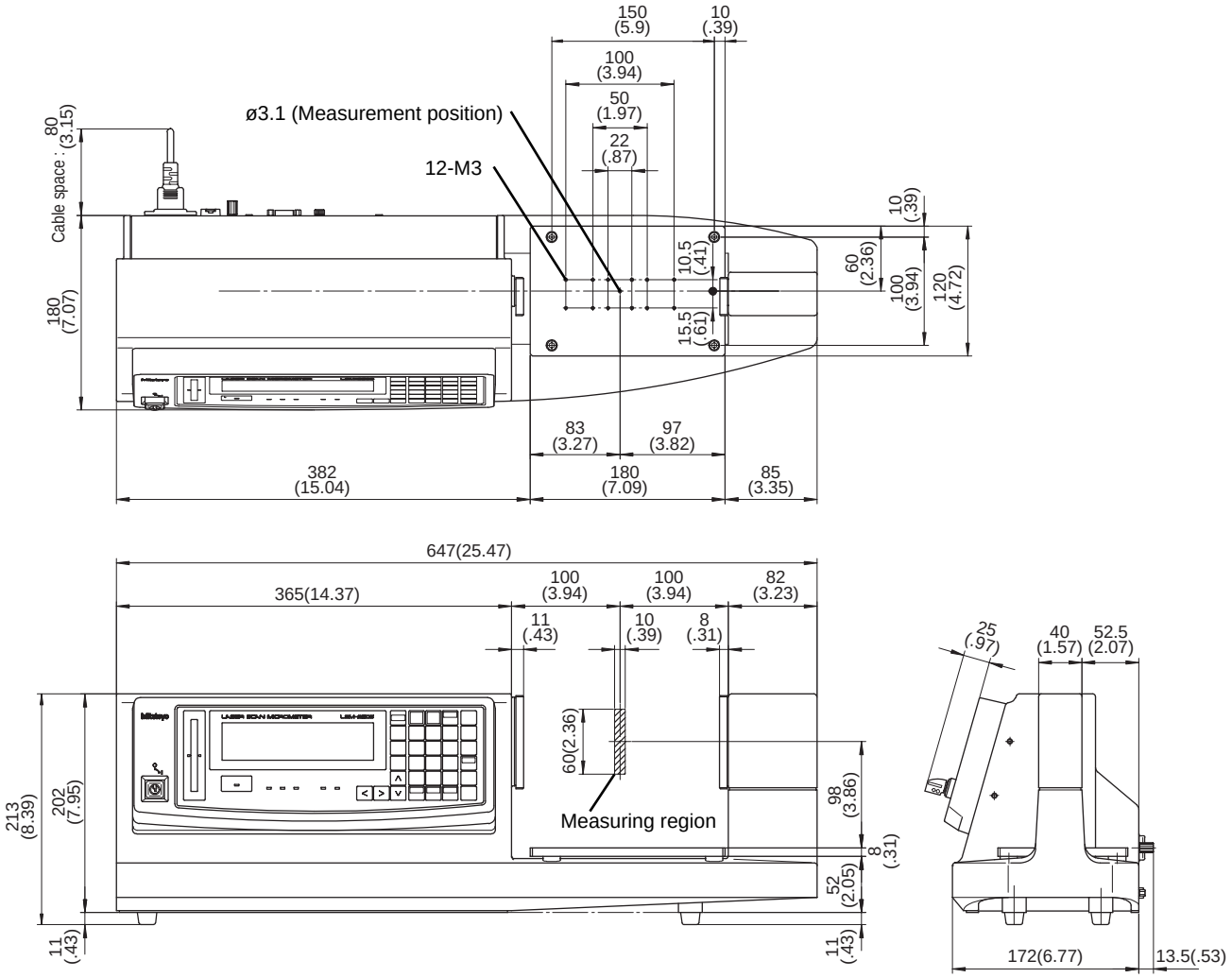
Part No.	Item	Quantity
	Power cord Note 1)	1
934626	GND lead wire (Green/Yellow) Note 1)	1
02ADC020	GND lead wire (Gray) Note 1)	
956042	Short-circuiting pin for remote interlock connector (delivered as mounted on the display unit)	1
214938	Remote interlock connector (PJ-2, manufacturer: Sato Parts)	1
02AGC401	Scan signal monitoring connector (PJ-2240-P)	1
02AGC605	Fuse 1A (Time lag) (Available from UL, CSA) Note 2)	1
02AGC606	Fuse 1A (Time lag) (Available from SEMKO, BSI) Note 2)	
02AGC604	Power key switch	2
99MBC032A	User's Manual (for 544-115A, 544-116A) Note 3)	1
99MBC031A	User's Manual (All models except for 544-115A and 544-116A) Note 3)	

Note 1, 2, 3: Depending on delivered country.

(3) Optional Accessories

Part No.	Item
936937	Digimatic Output Unit cable
02AGD600A	Printer cable set: DPU-414-30B + PW-4007-J1 (100 VAC)
02AGD600B	Printer cable set: DPU-414-30B + PW-4007-U1 (120 VAC)
02AGD600C	Printer cable set: DPU-414-30B + PW-4007-E1 (230 VAC)
223663	Printer paper (10 rolls)
937179T	Footswitch

(4) External view and dimensions



Unit : mm (inch)

9 RESTRICTIONS ASSOCIATED WITH THE COMBINATION OF FUNCTIONS, TABLES OF THE BASIC SETUP MODES

This chapter describes the restrictions associated with the particular combination of functions. It also describes the basic setup modes using tables.

9.1 Restrictions Associated with the Particular Combination of Functions

The following restrictions exist for function combinations.

a. Restrictions on the combination of functions for single measurement are as follows:

Functions combinations		Edge specification: Manual measurement	Edge specification: Automatic measurement	Transparent object measurement	Automatic workpiece detection	Abnormal value elimination	Sample measurement	Moving average	Group judgment
Edge specification	Manual measurement		—	—	○	○	○	○	○
	Automatic measurement	—		—	○	—	—	—	—
Transparent object measurement		—	—		○	○	○	○	○
Automatic workpiece detection		○	○	○		○	○	—	○
Abnormal value elimination		○	—	○	○		○	○	○
Sample measurement		○	—	○	○	○		○	○
Moving average		○	—	○	—	○	○		—
Group judgment		○	—	○	○	○	○	—	

Note: "o" indicates permitted combinations, and "-" indicates combinations that are not permitted.

b. The following restrictions are applied to the combinations of functions depending on the measurement method:

		Single measurement	Simultaneous measurement
Edge specification	Manual measurement	△	—
	Automatic measurement	△	—
Transparent object measurement		△	△
Automatic workpiece detection		△	—
Abnormal value elimination		△	△
Sample measurement		△	△
Moving average		△	—
Group judgment		△	—

Note: "△" indicates permitted combinations under the restrictions shown in the a) section. "-" indicates combinations that are not permitted.

9.2 List of Setup Modes

Tables in the following are the list of setup modes. Use these tables to check the setup data.

1. Make a check in the squares at the left of the mode number or in the setting content column that need to be set up.
2. Fill in the setup values for the underlined part.
3. If these setup values are frequently changed, make copies of these forms.

9.2.1 List of basic setup modes

Mode No.	Setup item	Setup contents	Default setup
B0	a: Resolution (RES)	☐ 0 : 0/ ☐ 1 : 1/ ☐ 2 : 2/ ☐ 3 : 3/ ☐ 4 : 4/ ☐ 5 : 5/ ☐ 6 : 6/ ☐ 7 : 7	0
	b: Number of blank-out digits (BLN)	☐ 0 : No blank-out/ ☐ 1 : 1 digit/ ☐ 2 : 2 digits	0
	c: Mark of thousandth digit (◇)	☐ NONE : No mark/ ☐ USE : Mark	NONE
	d: Buzzer sound (BUZZER) Note: System error alarm can not be prohibited.	☐ ALL : Sounds at any event. ☐ KEY : Sounds when key input is made (indicating acceptance or operation error). ☐ NG : Sounds when a NG measurement results. ☐ NONE : Does not sound except a system error alarm.	ALL
	e. Display latch timer (LATCH)	☐_____sec.	10
B1	a. Output in the ready state (D.OUT)	☐ NONE : Does not output the GO/NG judgment ☐ OUT : Output the GO/NG judgment	NONE
	b. Message in the event of Err-0 (ERR-0 D)	☐ ERR-0 : Displays “Err-0”. ☐ 0 : Displays “0”.	ERR-0
	c. Message at the start of me asurement (RUN D)	☐ ---------- : Displays “-------”. ☐ PREB.D : Displays the previous data	----------
	d. Method of average (AVG.M)	☐ ARITHM : Arithmetic average / ☐ MOVING : Moving average	ARITHM
	e. Method of GO/NG judgment (JDG.M)	☐ LL-LH : Judges with the lower limit and upper limit ☐ L1-L6 : Judges by multi-stage selection ☐ N-UL : Judges with the target value + tolerance f : Method of using the target value and reference value (COPY) ☐ NONE : Does not copy the target value on the reference value ☐ NO-REF : Copies the target value on the reference value	LL-LH (NONE)
B2	a. Workpiece type (WORK.P)	☐ OPAQUE : Opaque object ☐ TRANS : Transparent object	OPAQUE
	b. Simultaneous measurement (PROG)	☐ SINGLE : Single measurement ☐ DUAL : Simultaneous measurement	SINGLE
	c. Method of segment designation (SEG)	☐ SEGMENT : Segment specification ☐ EDGE : Edge specification	SEGMENT

Mode No.	Setup item	Setup contents	Default setup
B3	a. Abnormal value elimination (ADE)	☐ NONE : Does not use / ☐ USE : Use.	NONE
	b. Automatic workpiece detection (AWDT)	☐ NONE : Does not use. ☐ DIA : OD detection / ☐ POSITN : Position detection c: Number of scans ☐ 16 : 16 times / ☐ 1 : 1 time	NONE 16
	d. Group judgment (GTJ)	☐ NONE : Does not use. ☐ USE: Uses. e. Setting the group judgment result output (GTJ D) ☐ NONE : Does not output. ☐ OUT : Outputs.	NONE
B4	a. RS-232C port (RS-232C)	☐ COM : Uses for communication with PC ☐ PRN : Uses as a printer port (GP-IB is also available) ☐ NONE : Does not use. (GP-IB is also available)	COM
	b. Baud rate (BAUD)	☐ 9600 / ☐ 19200 / ☐ 1200 / ☐ 2400 / ☐ 4800	9600
	c. Data bits (LENGTH)	☐ 8 : 8 bits/ ☐ 7 : 7 bits	8
	d. Parity check (PARITY)	☐ NONE : Does not use. ☐ ODD : Odd parity ☐ EVEN : Even parity	NONE
	e. Delimiter (DELIMT)	☐ CR+LF: CR + LF / ☐ CR: CR / ☐ LF: LF	CR+LF
	f. line control (CONTRL)	☐ NONE : Does not use. ☐ USE: Uses.	NONE
B5	Reserved		
B6	a. Use of DCU (DCU)	☐ NONE : Does not use. ☐ USE : Uses.	NONE

9.2.2 List of calibration functions

Mode No.	Setup item	Setup contents	Setup range	Default setting
CAL	HIGH CAL	☐ HC : HIGH CAL gage = _____	Max.7 digits in the positive direction only.	Cancel (0)
	LOW CAL	☐ LC : LOW CAL gage =_____	Max.7 digits in the positive direction only.	Free (0)

9.2.3 Reading in the amount of light

Mode No.	Setup contents	Setup range	Default setting
Light amount detection	☐ AUTO : Automatically performs light amount detection. ☐ READ : Reading in the light amount.	—	AUTO

9.2.4 List of function setup modes

Program No.: _____ ___/___

Mode No.	Setup item	Setup contents	Setup range	Default setting
F0	Segment specification*	SEG : Segment No. =_____	Max. 7 positions	1
	Edge specification*	EDG : Use of automatic measurement ☐ NONE : Manual measurement ☐ PIT : Automatic pitch measurement ☐ DIA : Automatic diameter measurement ☐ GAP : Automatic gap measurement STRT : Start edge _____ END : Finish edge =_____	— 1 to 254 2 to 255	NONE • NONE 1 to 2 at NONE • PIT 2 to 5 at PIT • DIA 2 to 3 at DIA • GAP 3 to 4 at GAP
F1	Measurement interval	MR: Number of scans for averaging =_____ Arithmetic average (Guidance: MR ARM) Moving average (Guidance: MR MOV)	 1 to 2048 32 to 2048	 512 512
F2	(abnormal value elimination)*	EL : Lower abnormal limit =_____ EH : Upper abnormal limit =_____	Sign + max. 7 digits Sign + max. 7 digits	Free (0)
	GO/NG judgment*	LL : Lower limit value =_____ LH : Upper limit value =_____	Sign + max. 7 digits Sign + max. 7 digits	Free (0)
		L1 : Multi-limit selection 1 =_____ L2 : Multi-limit selection 2 =_____ L3 : Multi-limit selection 3 =_____ L4 : Multi-limit selection 4 =_____ L5 : Multi-limit selection 5 =_____ L6 : Multi-limit selection 6 =_____	Sign + max. 7 digits Sign + max. 7 digits Sign + max. 7 digits Sign + max. 7 digits Sign + max. 7 digits Sign + max. 7 digits	Free (0)
		NO : Target value =_____ LO : Lower tolerance limit =_____ UP : Upper tolerance limit =_____	Sign + max. 7 digits Sign + max. 7 digits Sign + max. 7 digits	Free (0)
F3	Reference value*	REF : Reference value =_____	Sign + max. 7 digits	Free (0)
F4	Offset	OFS : Offset value =_____ DIR : Direction =_____ MST : Mastering value =_____	Sign + max. 7 digits 0, 1 Sign + max. 7 digits	Free (0)
F5	Data output condition	DAT O.C : Data output condition =_____ DAT TIM : Periodic data output timer =_____	0 to 9 0 to 999 sec	Free (0)
F6	Sample measurement	SMP N : Number of samples =_____ SMP ITM : Statistical item ☐ AVG : Mean / ☐ MAX : Maximum value / ☐ MIN :Minimum value / ☐ RNG : Range	0 to 999 —	Free (1) AVG
F7	Automatic workpiece detection* (Position detection should be made in the positive direction only.)	AUT N : Number of measurement times = _____ AUT TIM : Invalidation period =_____ ms AUL : Lower detection limit =_____ AUH : Upper detection limit =_____	0 to 999 0 to 9999 Sign + max. 7 digits Sign + max. 7 digits	Free (0)
F8	Group judgment*	GTJ N : Group size subject to judgment = _____ GTJ ITM : Statistical item applied for group judgment ☐ GAG : Mean ☐ GMX : Maximum value ☐ GMN : Minimum value ☐ GRG : Range GLL : Group lower limit =_____ GLH : Group upper limit =_____	0 to 99 — Sign + max. 7 digits Sign + max. 7 digits	Free (0) GAG

* Varies depending on the basic set up.

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SERVICE NETWORK

Mitutoyo America Corporation
Illinois Repair Service
958 Corporate Blvd., Aurora, IL. 60504, U.S.A.
TEL: (630)820-3334 FAX: (630)820-2530
Michigan Repair Service
45001 Five Mile Rd., Plymouth, MI 48170, U.S.A.
TEL: (734)459-2810 FAX: (734)459-0455
Los Angeles Repair Service
16925 East Gale Ave., City of Industry, CA 91745, U.S.A.
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TEL: (978)692-7474 FAX: (978)692-9729
Charlotte Metrology Center
TEL: (704)875-8332 FAX: (704)875-9273

Mitutoyo Canada Inc.
2121 Meadowvale Blvd., Mississauga, Ont. L5N 5N1, CANADA
TEL: (905)821-1261 to 3 FAX: (905)821-4968

Mitutoyo Sul Americana Ltda.
AV. João Carlos da Silva Borges, 1240, CEP 04726-002 Santo Amaro P.O. Box 4255 São Paulo, BRASIL
TEL: (011)5643-0000 FAX: (011)5641-3722
Argentina Branch
Av. Mitre 891/899 -C.P.(B1603CQI) Vicente Lopez-Pcia. Buenos Aires, ARGENTINA
TEL: (011)4730-1433 FAX: (011)4730-1411

Mitutoyo Mexicana S.A. de C.V.
Prol. Ind. Electrica #15 Col. Parq. Ind. Naucalpan C.P.53370, Naucalpan, Edo. de Mexico, MEXICO
TEL: 05-312-5612 FAX: 05-312-3380

Mitutoyo Meßgeräte GmbH
Borsigstr. 8-10, 41469 Neuss F.R. GERMANY
TEL: (02137)102-0 FAX: (02137)8685

Mitutoyo Polska Sp.z o.o.
ul. Minska, nr54-56, Wroclaw, POLAND
TEL: (0048)71-3548350 FAX: (0048)71-3548355

Mitutoyo Nederland B.V.
Postbus 550, Landjuweel 35, 3905 PE Veenendaal, NETHERLANDS
TEL: 0318-534911 FAX: 0318-516568

Mitutoyo Scandinavia A.B.
Box 712, Släntvägen 6, 194 27 Upplands-Väsby, SWEDEN
TEL:(07)6092135 FAX: (07)6092410

Mitutoyo Belgium N.V.
Hogenakkerhoekstraat 8, 9150 Kruibeke, BELGIUM
TEL: 03-254 04 04 FAX: 03-254 04 05

Mitutoyo France S.A.R.L.
123, rue de la Belle Etoile, B.P. 50267-Z.I. Paris Nord II 95957 Roissy CDG Cedex, FRANCE
TEL: (01)49 38 35 00 FAX: (01)49 38 35 35
Mitutoyo France S.A.R.L., Agence de Lyon
TEL: (04) 78 26 98 07 FAX: (04) 72 37 16 23
Mitutoyo France S.A.R.L., Agence de Strasbourg
TEL: (03) 88 67 85 77 FAX: (03) 88 67 85 79

Mitutoyo Italiana S.R.L.
Corso Europa No.7, 20020 Lainate, Milano, ITALY
TEL: (02)935781 FAX: (02)9373290

Mitutoyo Schweiz AG
Steinackerstrasse 35, 8902 Urdorf-Zürich, SWITZERLAND
TEL: (01)7361150 FAX: (01)7361151

Mitutoyo (U.K.) Ltd.
Joule Road, West Point Business Park, Andover, Hampshire SP10 3UX UNITED KINGDOM
TEL: (01264)353123 FAX: (01264)354883

Mitutoyo Asia Pacific Pte. Ltd.
Regional Headquarters
24 Kallang Avenue, Mitutoyo Building, SINGAPORE 339415
TEL: 6294-2211 FAX: 6299-6666
Mitutoyo (Malaysia) Sdn. Bhd.
Suite G.2 Ground Floor, 2A Jalan 243, Section 51A 46100 Petaling Jaya, Selangor Darul Ehsan, MALAYSIA
TEL: 03-7845-9318 FAX: 03-7845-9346
Mitutoyo Thailand Co.,Ltd.
No.668/3, Moo7 Chaengwattana Rd. Anusaowaree, Bangkaen, Bangkok 10220, THAILAND
TEL: (02)521-6130 to 5 FAX: (02)521-6136
Representative Office
Indonesia:
TEL: 021-526-0737 to 8 FAX: 021-526-0736
Vietnam (Ho Chi Minh City):
TEL: (08)910-0485 to 6 FAX: (08)910-0487
Vietnam (Hanoi):
TEL: (04)934-7098 FAX: (04)934-7072
Philippines:
TEL: (02)842-9305 FAX: (02)842-9307

Mitutoyo South Asia Pvt. Ltd.
C-122, Okhla Industrial Area, Phase-I, New Delhi-110 020, INDIA
TEL: 011-6372091 to 2 FAX: 011-6372636

Mitutoyo Taiwan Co.,Ltd.
5th FL. No.123, Wu Kung First Road, Wu Ku Industrial Park, Taipei Hsien, TAIWAN, R.O.C.
TEL: (02)2299-5266 FAX: (02)2299-2358

Mitutoyo Korea Corporation
KOCOM Building 2F, #260-7, Yeom Chang-Dong, Kang Seo-Gu, Seoul, 157-040, KOREA
TEL: (02)3661-5546 to 7 FAX: (02)3661-5548

Mitutoyo (Beijing) Liaison Office
#1011, Beijing Fortune Bldg., No.5 Dong Sanhuan Bei-Lu Chaoyang District, Beijing 100004 P.R.CHINA
TEL: 010-65908505 FAX: 010-65908507

Mitutoyo Measuring Instruments Co., Ltd.
Shanghai:
Room B 11/F, Nextage Business Center No.1111 Pudong South Road, Pudong New District, Shanghai, 200120, P.R. CHINA
TEL: 021-5830-7718 FAX: 021-5830-7717
Suzhou:
46, Bai Yu Street, Suzhou, P.R. CHINA
TEL: 0512-62522660 FAX: 0512-62522580

Mitutoyo Corporation

20-1, Sakado 1-chome, Takatsu-ku, Kawasaki, Kanagawa 213-0012, Japan
Cable: MITUTOYO Kawasaki Telex: 3842-118
Phone: (044)813-8230 Fax: (044)813-8231

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